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STATE ENTOMOLOGIST
New York

Nos. 1 - 2

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FIRST ANNUAL REPORT

ON THE

INJURIOUS AND OTHER INSECTS

OF THE

STATE OF NEW YORK.

Made to the State Legislature, Pursuant to Chap. 377 of the Laws of 1881.

By J. A. LINTNER,

STATE ENTOMOLOGIST.

WITH THE COMPLIMENTS OF

J. A. LINTNER,

Albany, N. Y.

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OF THE

STATE ENTOMOLOGIST.

Hon. GEORGE G. HOSKINS,

Lieutenant-Governor, and President of the Senate:

SIR — I have the honor to present to the Legislature of the State of New York, the First Annual Report of the State Entomologist, made in accordance with the requirements of Chapter 377 of the Laws of 1881.

Very respectfully,

J. A. LINTNER.

ALBANY, N. Y., *Jan.* 12, 1882.

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REPORT.

To the Legislature of the State of New York:

The Entomologist, in accordance with the requirement of the act establishing the office of State Entomologist, would respectfully present the following report: —

In assuming the duties with which he is specially charged — "the study of insects injurious to agriculture and of methods for controlling and preventing their depredations." — he has done so in earnest devotion to his department of study — with a sense of responsibility arising from the magnitude of the field of his investigations and its consequent demands — a conviction of the great importance of such studies — a determination that, to the extent of his ability, they shall be made to promote the interests of the State, and the hope that they will contribute to the obligations under which other States and countries have already been placed to the State of New York, by her valuable contributions to applied science.

IMPORTANCE OF ENTOMOLOGICAL STUDY.

It should not be necessary in this enlightened age, marked by so great advance in every department of science, to urge the importance of the study of the Insect world. A century ago, when Entomology and many of the allied sciences were in their infancy, it was popular, and perhaps excusable, to ridicule the study, which frequently extended no further than the gratification afforded by the possession of a cabinet of insects properly labeled and systematically arranged. Those devoted to the pursuit were looked upon as occupied with trifles. Such views are still held at the present day by those who are ignorant of the great change that a century has wrought, and of the practical purposes which this preliminary work of collecting, naming, and describing have meantime been made to serve. The study of insects has

assumed an importance in its direct application to advancement in agriculture, horticulture and sylviculture, second to no other department of natural history. It has called to its furtherance some of the best intellect in this country and in Europe. The literature of entomology has become extensive and assumed honorable rank. Five monthly publications exclusively devoted to the science are ably sustained. A list of American entomologists lately compiled contains nearly a thousand names. Several of our States are employing State entomologists, and others, in compliance with demands made upon them by agriculturists and others, are moving for their appointment. The Department of Agriculture at Washington is earnestly engaged in entomological work, through its Entomologist and corps of assistants; and the General Government has for several years been sustaining a Special Commission, through liberal appropriations, charged with the investigation of a few of our more injurious insects whose excessive ravages and wide-spread distribution have given to them a national importance.

The importance of entomological study may be more fully shown by some further considerations which I beg leave to present:

1. Extent of Insect Depredations.

It has been truthfully said that insects have established a kind of universal empire over the earth and its inhabitants. Minute as many of them are, and insignificant in size to other than naturalists, yet, in combination, they have desolated countries and brought famine and pestilence in their train. If unrestrained power could be given them, all counter-checks removed, and they were left free to attack us in our persons, food, clothing, houses and domestic animals, the consequent disease, poverty, exposure, and want, would, in the end, remove the human race from the face of the earth. Air, earth and water teem with them; there may be claimed for them almost an omnipresence; they swarm in the tropics, and find a suitable home in the Arctic regions. They abound in our homes, our gardens, orchards, fields, vineyards, and forests. In the vegetable kingdom they are found in the seed, the root, the stalk or trunk, the pith, the bark, the twig, the bud, the leaf, the blossom, and the fruit — within or upon every portion of the vegetable organism. They are parasitic on our persons and upon or within all of our domestic animals. They attack and destroy fishes and birds. They have their natural home in many of our articles of food. By their disgusting presence and annoyance they may render our homes untenable. They burrow within our household and agricultural implements. They occasionally take possession of our books.

No asylum is so secure that they may not intrude; no condition in life is exempt from their presence and attack.

From this general diffusion there necessarily results extensive losses. Provided often with wonderful means for self-preservation and for the perpetuation of the species, they are ever ready in the exercise of their powers to dispute with man his claim of exclusive right in property. Never without the imposition of a heavy tax upon the products of his labor, they often manifest a determination to wrest from him the entire results of a season's toil. Many of the more injurious species living solely upon such vegetable productions as man regards as essential to his welfare and almost indispensable to his existence, there follows as the consequence of the "struggle for life," continual collision and antagonism. Have the study and labor of a long series of years at length brought the products of his garden and his orchard to such a degree of perfection that only traditionary lore can trace therein specific identity with the wild, uncultivated parent-plant, it would seem, at times, as if all this improvement served no other end than to provide more sumptuous repasts to augmented hordes of insects with greatly increased powers of destructiveness.

To the vegetable world, insects are mainly indebted for their sustenance, and a vegetable growth entirely free from insect attack would be an anomaly in nature. From careful and extended observations, it has been estimated that there are, upon an average, six species of insects attacking each species of plant. Upon most of our cultivated plants, such as garden vegetables, shrubs, trees, grasses, cereals, etc., they have become quite numerous, for the qualities resulting from careful culture which have made them more valuable to us, have, at the same time, rendered them more attractive to insects. Ten years ago (since which time great progress has been made in economic entomology), Dr. Packard stated*: "I could enumerate upwards of fifty species of insects which prey upon cereals and grasses, and as many which infest our field crops. Some thirty well-known species ravage our garden vegetables. There are nearly fifty species which attack the grape-vine, and their number is rapidly increasing. About seventy-five species make their annual onset upon the apple-tree, and nearly as many may be found upon the plum, pear, peach, and cherry. Among our shade trees, over fifty species infest the oak: twenty-five the elm: seventy-five the walnut, and over one hundred species prey upon the pine."

The above stated numbers have already been found to be much below the truth. Several, if not all of them, may be safely doubled, for

*First Ann. Rep. Ins. Mass., 1871, p. 5.

on the apple tree above one hundred and sixty species are now known to occur.* Fifty-two species of *Tineidæ* alone are recorded upon the oak, by far the larger number of which are leaf-miners.†

Perhaps the extent to which the depredations of a single insect may extend cannot be better illustrated than by reference to the grape phylloxera — *Phylloxera vitifoliæ* (Fitch), a minute insect, belonging to the family of *Aphididæ*, or plant-lice. The earliest notice of this species was that given by Dr. Fitch, in the year 1855, who briefly noticed it under the name of *Pemphigus vitifoliæ*, as forming small galls on the margin of the leaves of some grape-vines, in Washington county, N. Y.‡ By some means the species was carried to Europe, and it was detected in France, in 1868, by Prof. Planchon, infesting the roots of grape-vines. Believing it to be an undescribed species, it was

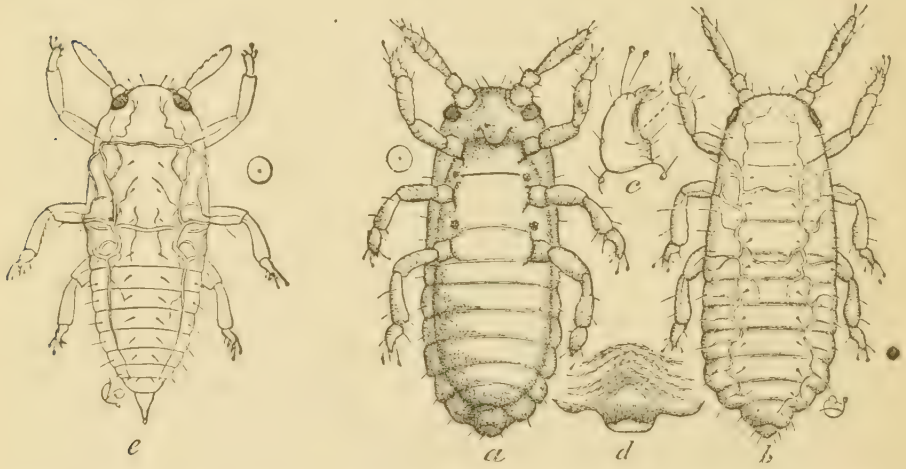

FIG. 1.— SEXED PHYLLOXERÆ:—*a*, female *vitifoliæ*, ventral view, showing egg through transparent skin; *b*, dorsal view; *c*, greatly enlarged tarsus; *d*, shrunken anal joints, as they appear after oviposition; *e*, male *P. caryæcaulis*, dorsal view. The dots in circles indicate the natural size.

*In the Appendix (B.) will be found a list of the apple-tree insects of the United States as far as I have noted them. It contains one hundred and seventy-six species. Although quite incomplete, it is published at this time in order to invite additions by those who may discover omitted species. I purpose, as soon as practicable, to present a report on our apple-tree insects, which shall contain notices of all of our known species, with figures illustrating them as far as possible, together with the most effectual methods for preventing their injuries.

†Chambers' *Food-plants of Tineina—Bull. U. S. Geolog.-Geograph. Surv. Terr.*, iv, 1878, pp. 119, 120.

‡*Transactions of the New York State Agricultural Society* for 1854, vol. xiv, 1855, p. 862.

subsequently published by him as *Phylloxera vastatrix*. Later, through comparison and study of the different forms, the identity of the root-inhabiting and the leaf-inhabiting forms was established. Since that time, notwithstanding the most earnest efforts to arrest its spread, aided by legislation, munificent grants, and the learning of the most distinguished scientists, it has continued to extend its area and increase its ravages, until it has invaded every vineyard in France, and threatens the entire destruction of the cultivation of the vine. The female, greatly enlarged, is shown in Fig. 1 with a dot beside it indicating its natural size. The male of a very similar species is also shown.

It is just announced that almost everywhere in the French wine districts, windlasses are at work tearing up blackened vines killed by the phylloxera, and it is estimated that nearly 1,000,000 acres of vineyards have been cleared and the land turned to other uses. The interest and the alarm caused by these ravages are shown by the reward of 300,000 francs ($60,000), which has been offered by the French Government, for the discovery of a method of destroying the insect; and the large grants which have, for several preceding years, been placed at the disposal of the French Minister of Agriculture and Commerce, for the purpose of encouraging research and experiments as to the best way of dealing with the phylloxera, have, during the present year, been increased to the amount of 969,750 francs (nearly $200,000).

The insect has also made its appearance in Australia, and such are the apprehensions that its introduction has excited, that Victoria, New South Wales, and South Australia are to contribute $100,000 toward the expense of exterminating it.*

The minute size of this insect, scarcely more than a microscopic dot in several of its stages, and in its winged state less than one-tenth of an inch in length, always needing a microscope for its observation, exemplifies the apparent paradox often met with in the insect world — the smaller the creature the greater its power of injury.

2. Losses from Insect Depredations.

Could approximate estimates be had of the pecuniary losses resulting from these depredations on our principal crops, the figures obtained would be the only arguments needed to enforce the importance of investigation

* *Psyche*, iii, 1881, p. 215.

tions to arrest them. There is probably not a single crop cultivated which the infesting insects do not diminish by at least one-tenth — an amount of injury which would hardly be noticed. They often injure crops to the extent of one-fourth or one-half, and occasionally entirely destroy them, as during the ravages of the wheat-midge — *Diplosis tritici* (Kirby) in this State, in 1854–1857, when entire fields were left unharvested.* One of our ex-Governors, in his agricultural addresses, has frequently urged that insect depredations upon crops of one-fourth or one-half their value should be regarded as a direct tax of twenty-five per cent or fifty per cent levied upon their full value, and collected, perhaps, year after year, without a show of resistance; but which each farmer could, and therefore should, resist, and thereby relieve himself from at least a portion of the burden.

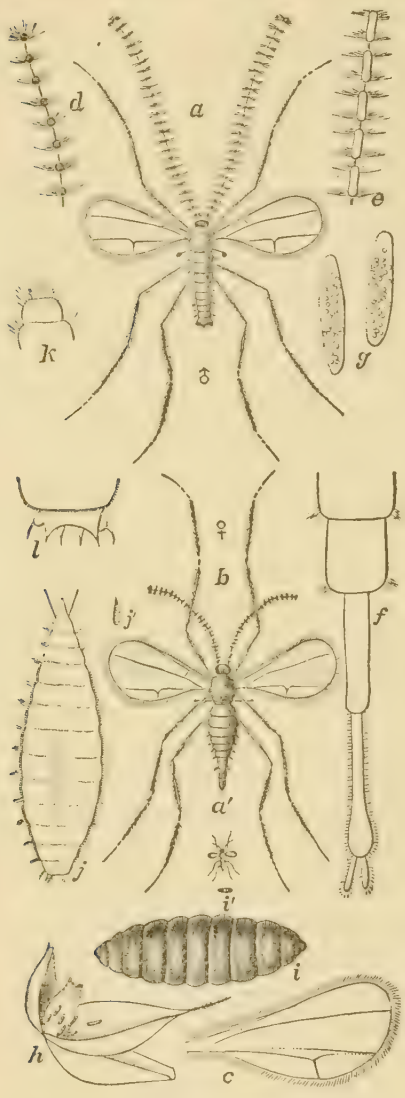

FIG. 2.— THE WHEAT-MIDGE (after Fitch): *a*, male midge; *b*, female do.; *a'*, its natural size; *c*, wing much enlarged; *d*, antennal joints of male; *e*, ditto, of female; *f*, ovipositor, with its two sliding-tubes and terminal finger-like appendages, for guiding the eggs; *g*, eggs, greatly magnified; *h*, a flower of wheat showing the larvæ upon the kernel; *i*, larva in repose; *i'* its natural size; *j*, larva crawling with its horns extended; *j'*, its natural size; *k*, greatly enlarged view of anterior end when moving on a dry surface with its horns but partially extended; *l*, posterior end with teeth protruded to aid in motion.

Among the estimates made of these losses occurring throughout the United States are the following:

The loss to the wheat crop in the State of New York, in the year 1854 from the wheat-midge, was estimated, from carefully collected data, by the Secretary of the State Agricultural Society, at above *fifteen millions of dollars*.† The amount would be a third larger if estimated at the price to which wheat afterward arose that winter. (The insect in its natural size and as it appears when magnified is shown in Fig. 2, together with its eggs and larvæ).

From estimates made by the Secretary of the Ohio State Board of

*In 1856, in Livingston county, N. Y., 2,000 acres, on flats which would have yielded thirty bushels an acre, were not harvested.

†Fitch's Sixth Report (p. 12), *Transactions New York State Agricultural Society*, XX, 1860, p. 754.

Agriculture, the loss to the wheat crop from the same insect during the same year in that State was even greater than in New York.

In 1857, the insect having extended its ravages over a larger portion of the State of New York, the loss exceeded that of 1854. In Canada, the same year, it destroyed about *eight millions of bushels.*

The cash value of the wheat and corn destroyed in the year 1864, in the State of Illinois, by the chinch-bug — *Blissus leucopterus* (Say), is estimated at *seventy-three millions of dollars.**

The same insect injured the wheat, oats, and corn in the State of Missouri in 1874, as appears from estimates made in the larger number of counties in the State, to the amount of *nineteen millions of dollars.*†

The loss to corn, potatoes and other crops in the States of Kansas, Nebraska, Iowa, and Missouri in 1874, from the ravages of the Rocky Mountain locust — *Caloptenus spretus* Uhler, is computed by the United States Entomological Commission at nearly *fifty-six millions of dollars*, and the actual loss to the four States is estimated at one hundred millions of dollars.‡ The insect is shown in Fig. 3, at *a*, in

a. *b.*

Fig. 3.—The Rocky Mountain Locust *a*, compared with the Red-legged locust (*Caloptenus femur-rubrum b*).

comparison with the shorter winged red-legged grasshopper (*Caloptenus femur-rubrum*), at *b*, common in the State of New York and in most of the Northern United States east of the Mississippi river.

For the same insect, from county returns of loss upon grain alone in the western portion of Missouri, in 1875 (omitting several counties that made no returns), Professor Riley figures an aggregate in twenty-six counties of *fifteen millions of dollars.*§ Single counties suffered to the extent of *two millions of dollars.*

Careful estimates of damage sustained from the cotton-worm — *Aletia argillacea* Hübner (the moth of which is represented in Fig. 4), upon an assumed value of $50 per bale on the number of bales less than an average crop, give, as the annual loss for the fourteen years prior to 1878, in several of the cotton States, the following amounts: Georgia, $3,912,000; Louisiana, $4,487,000; Alabama, $4,789,000; Mississippi, $6,150,000; Texas, $7,406,600; and in nine of the principal cotton States, the following result:

Fig. 4.— The Moth of the Cotton Worm (*Aletia argillacea* Hübn.)

* Riley's *Second Rep. Ins. Mo.*, 1870, p. 28.

† *Seventh Report Ins. Mo.*, 1875, p. 25.

‡ *First Ann. Rep. U. S. Ent. Commis.*, 1878, p. 121.

§ Riley's *Eighth Rep. Ins. Mo.*, 1876, p. 90.

a possible loss of *thirty millions of dollars* in years of general prevalence of the caterpillar.*

From the census returns of the value of the agricultural products of the United States, and estimates of injuries inflicted by certain insects in several of the States, it has been computed that the aggregate annual losses from injurious insects throughout the Union equals *two hundred millions of dollars.*†

B. D. Walsh, who was one of the most able of our economic entomologists, gave it as his opinion that the United States suffer from the depredations of noxious insects to the annual amount of *three hundred millions of dollars.*‡

3. Excessive Insect Depredations in the United States.

The study of insects assumes an importance in this country far greater than in any part of the world. Nowhere else are insect injuries so serious as in the United States. Our several crops are attacked by a larger number of insect pests, and the losses that they inflict upon each are almost invariably in excess of those occurring in the countries of Europe. Three causes have concurred and are mainly instrumental in producing this condition:

1. **The Importation of Injurious Insects.**—Very few of our various agricultural products are native to our soil. Nearly all of our fruits, grasses, cereals, garden vegetables, and probably three-quarters of our weeds are of foreign importation — mainly from Europe. With their introduction very many of their attacking insects were also introduced or subsequently brought hither, as, for example, the wheat-midge (*Diplosis tritici*), the currant-worm (*Nematus ventricosus*), the oyster-shell bark-louse (*Mytilaspis pomicorticis*), the apple-tree plant-louse (*Aphis mali*), the hop-louse (*Aphis humuli*), the grain-Aphis (*Siphonophora avenæ*), several other species of plant-lice, the codling-moth of the apple (*Carpocapsa pomonella*), the cabbage-moth (*Ephestia interpunctella*), the cabbage-butterfly (*Pieris rapæ*), the currant-borer (*Ægeria tipuliformis*), the asparagus-beetle (*Crioceris asparagi*), the clover-root borer (*Hylastes trifolii*), the onion-fly (*Anthomyia cepariun*) and several other root-flies, the boll-worm or the corn-worm (*Heliothis armiger*), and a number of destructive cut-worms (*Agrotis c-nigrum, A. baja, A. prasina, A. plecta, A. saucia, A. ypsilon, Mamestra trifolii, Hadena Arctica*), etc.

Comparatively few of our native injurious species have been introduced in Europe, consequently the number of those imported to this

*Comstock's *Report upon Cotton Insects*, 1879, p. 70.

†Packard, in *Hayden's 9th Annual Report U. S. G.-G. Surv. Terr.*, 1877, p. 591.

‡*American Entomologist*, i, 1868, p. 2.

country so greatly exceed those exported, that the preponderance, added to our native forms, seems to warrant the assertion that "America is the home of insects."

2. The Increased Destructiveness of Introduced Insects.—It is well known to entomologists that those of our insect pests which are of European origin have become far more injurious here than they were ever known to be in their native homes. This may be illustrated by a reference to a few of our injurious species. The wheat-midge, introduced to this country about the year 1820, and first observed in Northern Vermont,* has never, throughout its entire European history, extending over nearly a century and a half, displayed an approach to the destructiveness which it has shown since its advent here. Its injuries have indeed, at times, created alarm and entailed serious losses in portions of England and Scotland, but on the Continent its existence was hardly known for a century after its discovery, and subsequent to that time it had not been very prevalent. Curtis, in writing of the species, calls it the *British wheat-midge* (indicating a restricted European range), and states that M. Herpin is of the opinion that it is an inhabitant of France.†

The ravages of the cabbage-butterfly, *Pieris rapæ* Linn., brought to this country by the way of Quebec, about the year 1858, have greatly exceeded those committed by it in Europe. It has proved very destructive to cabbages wherever it has appeared, and it seems destined to spread over all of the United States, as it crossed the Missouri river in 1880 and has entered Nebraska.‡

The asparagus-beetle, *Crioceris asparagi* (Linn.), which has at times destroyed entire plantations of asparagus upon our sea-board in the vicinity of New York, has been known for centuries in Europe, but has hardly been referred to by writers on economic entomology as an injurious insect. Although common in Russia, a writer in referring to it, in 1880, states, that it is never known to be obnoxious there.

The carpet-beetle, *Anthrenus scrophulariæ* (Linn.), first noticed in this country in the year 1872, has been recognized as a common species throughout a large part of Europe for more than a century. While in several portions of the United States its ravages on carpets have excited serious alarm in housekeepers and have threatened to compel a resort to uncarpeted floors, no instance is known of its ever having been detected in feeding upon carpets in Europe, although stated to be injurious to "furs, clothes, animal collections and even leather and dried plants." More frequent reference is made by Eu-

*Fitch, *Sixth–Ninth Reports Ins. N. Y.*, 1865, p. 8.
†*Farm Insects*, 1860, pp. 260, 266.
‡*Canadian Entomologist*, xiv, 1882, p. 40.

ropean writers of the occurrence of the beetle upon flowers than of the larva within houses.* (The insect, in its several stages, is shown in Fig. 5.)

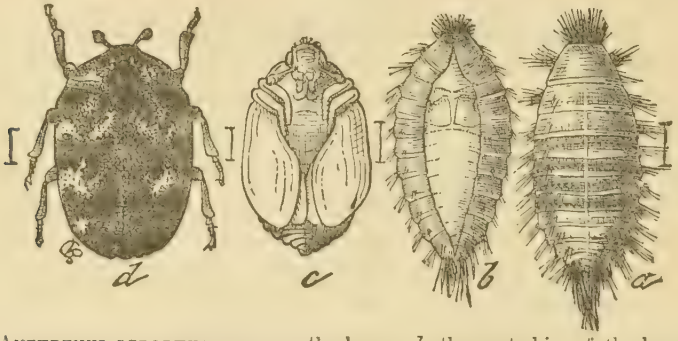

FIG 5.— ANTHRENUS SCROPHULARIÆ : *a*, the larva; *b*, the cast skin of the larva at molting; *c*, the pupa; *d*, the beetle — enlarged from natural sizes shown in accompanying lines.

The increased ravages of our introduced insects result from the new conditions under which they are here placed. The relations that during the lapse of centuries had grown up between them and their food-plants, their insect parasites, the birds and other animals that preyed upon them, whereby a balance and an interdependence had become established — have all been broken up. When brought to our shores they find, perhaps, more abundant food, of a character more acceptable and attractive to them. But mainly, in their importation, their natural parasites and the enemies which had kept them in subjection have been left behind, and they are free to ply their destructive work and to "increase and multiply" without hindrance or molestation, unless some of our native parasites shall at length acquire the habit of preying upon them, and other foes discover that they are "good for food."

3. The Large Areas Devoted to Special Crops.— The excessive ravages of insects in the United States are largely owing to the cultivation of their food-plants in extended areas. We may illustrate this by a reference to our apple-tree insects. Two hundred years ago not even the wild crab, the earliest representative of the apple, existed in this country, and consequently there were no apple-insects. Later, when a few apple-trees became the adjunct of the simple homes of the early settlers, those of our insects to which they offered more desirable food than that on which they had previously subsisted, were obliged to wing their way often for many miles in search of a tree upon which to deposit their eggs. If birds were then abundant, how few of the insects could safely accomplish such extended flights. But in the apple orchards of the present day — some of them spreading in an almost unbroken mass of foliage over hundreds of acres — our numerous apple

*Hagen, in *Canadian Entomologist*, x, 1878, p. 161.

insects may find the thrifty root, the vigorous trunk, the succulent twig, the tender bud, the juicy leaf, the fragrant blossom, and the crisp fruit spread out before them in broad array, as if it were a special offering to insect voracity, or a banquet purposely extending an irresistible invitation to the tent-caterpillar, the codling-moth, the canker worm, the striped-borer, the bark-beetle, the twig-borer, the leaf-aphis, the bark-louse, the root-louse and every other of our one hundred and sixty species of apple insects. Here they may luxuriate as nowhere else. The required food is greatly in excess of insect need. Careful cultivation has made it the best of its kind; appetite is stimulated; development is hastened; broods are increased in number; individuals are multiplied beyond the conservation of parasitic destruction; facilities of distribution are afforded with hardly a proper exercise of locomotive organs, and when these almost useless members have become aborted, as in the wingless females of the bark-louse (*Mytilaspis pomicorticis*) and the canker-worms (*Anisopteryx vernata* and *A. pometaria*), the interlocking branches afford convenient passage from tree to tree.

In like manner, every crop cultivated on a large scale, holds out strong invitation to insect attack, and wonderfully stimulates insect fecundity. Nowhere in the world are crops massed in so large an acreage as in this country — their extension ever keeping pace with the invention of special mechanical contrivances for their gathering, and the extent to which hand-labor and horse-power may be replaced by steam. The following are a few instances of extensive areas devoted to special products:

The largest apple-orchard in the world is believed to be that of Mr. McKinstry, near Hudson, N. Y. It embraces about 300 acres and contains 26,000 apple-trees. Extending for nearly a mile along the public highway and for one-half a mile in the rear, it appears, when viewed from some favorable point, like a vast sea of orchard. Six miles of road extend through the grounds for access and for carrying away the gathered fruit.*

The peach orchard of the Orchard Hill Fruit Farm, at Orchard Hill, Georgia, is believed to be the largest in the world. It contains 54,000 peach-trees, and occupies 540 acres. The proprietor, Mr. John D. Cunningham, informs me that he will probably plant 250 additional acres the coming fall, which would then give him 84,000 trees.

A fruit-grower in California (Mr. G. G. Briggs, of Davisville) has 1,010 acres of grape-vines, in four parcels of respectively 120, 160, 270, and 460 acres. Nearly all are muscats of Alexandria and are culti-

*Proceedings Western N. Y. Horticultural Society, at 26th Ann. Meet. in 1881, p. 81.

vated for raisins, the product of which, when all shall come to full bearing, is estimated at 200,000 boxes, or 4,000,000 of pounds.*

The cotton plantation of Col. B. G. Lockett, near Albany, Ga., contained in 1872, 6,500 acres of cotton.†

From the Dalrymple farm, in Nebraska, there were harvested 12,000 acres of oats and 24,000 acres of wheat. The grain was cut by 125 reaping machines moving in divisions, and a number of steam-threshing machines were employed.‡

In the San Joaquin Valley, in California, there were three wheat fields containing respectively 17,000, 23,000 and 36,000 acres. The crop of the latter was 1,440,000 bushels. One side of the field is seventeen miles long. When plowed, ten four-horse teams were attached to ten gang-plows, each gang having four plows. Lunch was served at a midway station and supper at the terminus.§

A Colorado potato field, near Denver (belonging to Mr. Rufus Clark) is 150 acres in extent, and its yield for 1864 was estimated at from 25,000 to 30,000 bushels. During the season more than $2,000 were expended in defense against the potato-beetle.**

In 1877, in Dighton, Mass., 1,000,000 quarts of strawberries were raised — over 30,000 bushels.

The tendency in our country appears to be toward the cultivation of special crops on a scale only limited by the means of handling them. It is but the natural result of the proverbial industry and energy of the American people; the great improvements recently made in agricultural implements; the rapid increase in population; increased facilities of transportation; and an increasing foreign demand for our products. But it is questionable, in view of the alarming increase of insect depredations, to what farther extent this aggregation of single food-plants may be carried, without the attendant multiplication of attacking insects to a point where it shall be impossible by any human means or by parasitic aid to prevent their obtaining the entire mastery of us.

4. The Immense Number of Insects.

In number of species, insects far exceed that of all the other classes of the animal kingdom combined, viz.: mammals, birds, reptiles, fishes, crustaceans, worms, etc.†† The number already known is

*For yield in former years, see *Country Gentleman*, xlvii, 1882, p. 208.

†*Report of the Commissioner of Agriculture for* 1872, p. 448.

‡*The Rural Nebraska* for November, 1880.

§*Country Gentleman*, xxxvii, 1872, p. 633.

**Report of the Commissioner of Agriculture for the year* 1874, p. 280.

††There are about 55,000 species of animals known, exclusive of insects. (*Packard's Guide to the Study of Insects*, 1869, p. 103.)

immense, and the new species that are being continually added to our lists, as the results of an increased number of observers, more thorough collections, and more extended explorations, is constantly enlarging the estimate which naturalists from time to time present of the probable number occurring throughout the world. The discovery of new forms is ever in advance of the ability of entomologists to give them description, name, and classification. There are to-day in the British Museum no less than 12,000 species remaining undescribed, and like unworked material is to be found in every collection of any extent in both hemispheres. Fifty years ago, 70,000 species had been described, and it was then thought that there were at least twice that number in existence. The scientific activity of the past half century has more than quadrupled that number, and there are now 320,000 described species. In view of this rapid increase, it will not be safe to assume that even yet one-half of the actual number have been described. From our present knowledge, and from the vast extent of the globe which is still, in natural science, *terra incognita*, it does not seem improbable that the number of insects in the world may reach a *million of species.*

Leaving the species and passing to individuals — if we proceed to a calculation of number, we almost question the results shown by our figures. Dr. Fitch has given us a computation of the number of cherry-tree aphids — *Aphis cerasi* Fabr. — occurring upon some trees upon his grounds. He writes:* "Among the cherry-trees alluded to, was a row of seven young ones which had attained a height of about ten feet. By counting the number of leaves upon some of the limbs and the number of limbs upon the tree, I find a small cherry-tree of the size above stated is clothed with about seventeen thousand leaves. These leaves could not have averaged less than five or six hundred lice upon each, and there was fully a third more occupying the stems and the tips of the twigs. Each of these small trees was, therefore, stocked with at least twelve millions of these creatures."

Even our knowledge of insect fecundity fails to explain such wonderful multiplication, and our reason cannot assign the purpose for which such seeming excess is designed. It is related of a little midge (*Chironomus niroriundus*), that, on one occasion, in traversing a forest it was observed in such countless myriads as to prove of the greatest annoyance to the tourist, getting into his mouth, nostrils, and ears at every step, and literally covering his clothing.†

The Rocky Mountain locust, in its migratory flights, hides the sun, and fills the air as far as the eye can reach. From the highest peaks

**First and Second Report on the Insects of New York*, 1856, p. 127.

†Fitch: *Winter Insects of Eastern New York; Amer. Jour. Agr.-Sci.*, v, 1846, p. 282.

of the Sierra Nevada, it has been seen filling the valleys below and the air above as much higher as they could be distinguished with a good field-glass.* Rich and fertile portions of Southern United States are incapable of cultivation from the hosts of mosquitoes that abound in them. The same insect effectually shuts out portions of British America from exploration, while in Eastern Europe and in Asia the attacks of its hosts have caused insanity in travelers, and the death of domestic animals unprovided with means of defense. The experiments of Reaumur have shown that a single aphis (a plant-louse) may, in a single year, through its frequent generations without pairing, be the progenitor of 5,904,900,000 (nearly six billions) descendants.

Through such prodigious multiplication, the tiny, often despised, insect attains an importance in the economy of nature to which the ravenous beast of prey may not attain, although surpassing it many thousand fold in size.

5. Necessity of a Knowledge of Insect Habits.

No great success can be expected in our efforts to resist insect depredations, until we know who and what our insect enemies are. We are told *who* they are, when they have been given the scientific name which they shall bear wherever they may occur throughout the civilized world; and we are first prepared to learn *what* they are, when they have been so intelligently described and faithfully illustrated that they may be unmistakably identified by the agricultural, as well as the scientific, student. Hundreds of persons, in different localities, may then be simultaneously engaged in the study of the same insect; or fact after fact may be separately ascertained and recorded, which, when collated and arranged, may so nearly furnish an entire life-history as to leave but a few inconsiderable details for special study to supply. The habits of the different species are so diverse as to necessitate separate study of each one of the immense number with which we have to do. Each history is a complicated one, as it embraces, for the greater part, four distinct forms of animal existence — the egg, the larva, the pupa, and the imago — which may differ so greatly one from the other, that, by the uninitiated, no relationship would be suspected. One or more of these forms may be artfully hidden, or existing under such peculiar circumstances as to elude discovery. Among the first hundred of our most injurious insects, there are those which we only know in their final stage, and there is not the naturalist among us who could identify them in their larval or their pupal state; while at least one-half of the number could not be determined in the egg. Such a confession

*First Ann. Rep. U. S. Entomolog. Commis., 1878, p. 213.

is a strong argument in favor of continued investigation of insect lives, for it must be evident that until the several stages are known, the entomologist is not prepared to point out the particular phase in which the insect is the most vulnerable, and recommend the remedy or the preventive that has been found by experiment to be the most efficient and the simplest in its application.

These studies are laborious. They often involve earnest, long-continued and painful cloister work, in microscopic observation of the more minute forms. Other information can only be obtained in the field, orchard, and forest. So many are the details that enter into a complete life-history, that a single one may be the accretion of the united labors of individuals extending over a series of years. The number of persons who are devoting their entire time, or any large proportion thereof, to economic entomology in the United States is less than a dozen — a number ludicrously small in view of the extent of our country, its varied interests, its range of agricultural products, and an amount of insect losses in large excess, as has been shown, of those occurring elsewhere, and which, for reasons already given, are increasing among our larger crops to an extent that will, ere long, compel the study for their arrest which is so unwisely withheld.

PROGRESS MADE IN ECONOMIC ENTOMOLOGY.

We do not overstate the truth, we think, in asserting that the last twenty years have been signalized by a progress in entomology, equal, at least, to that made during the preceding century. In every direction it has displayed a marked advance — in the extensive collections made in every quarter of the globe; in the species described and illustrated; the distinguished scientific ability devoted to the study; the systematic and biological collections arranged in our museums and private cabinets; the classificatory work accomplished; the valuable contributions to its general literature; the monographs, manuals, and catalogues of families and orders published through the Smithsonian Institution; the embryological and anatomical investigations; and, lastly, the utilization and application of all that has been accomplished in these several directions, to the promotion of the arts of agriculture, horticulture, and others, which minister to the comfort, happiness and well-being of mankind.

1. The Writings of Economic Entomologists.

Economic Entomology, in this country, had its commencement in the labors of Dr. T. W. Harris, and directly, in the publication of his *Report on the Insects of Massachusetts Injurious to Vegetation*, in

the year 1841. Successive editions of this admirable work have been subsequently published. Of these, the last, issued in 1862, with additions and copious illustrations, finds place in most of the principal libraries both here and in Europe, and its pages may ever be consulted with pleasure and with profit. It still remains the first volume which the entomologist recommends to those who desire to learn of the relations which we bear to the insect world. A writer gives it this high praise: "It has saved millions to our country, and has been received with enthusiasm in all the countries of Europe. It is an imperishable honor to Massachusetts."*

The writings of my predecessor, Dr. Asa Fitch, especially those contained in his series of *Reports on the Noxious, Beneficial and other Insects of the State of New York*, commencing in the year 1855 and terminating in 1872, have been of such eminent service in the promotion of economic entomology, that I have felt justified in devoting several pages of the Appendix (A.) to a notice of the circumstances attending his call to the duties of the office of Entomologist — the instructions under which his work was conducted — the time, place and manner of publication of the several reports (fourteen in number), together with some remarks upon his labors made after his decease, to the State Agricultural Society with which he was so long connected.

To Mr. B. D. Walsh, State Entomologist of Illinois at the time of his lamented death through a railroad casualty, are we indebted for valuable progress in both general and applied entomology. His State Report and the large number of valuable papers contributed by him to the *Practical Entomologist* and the *American Entomologist* (as editor of the former and associate-editor of the latter), to the *Proceedings of the Entomological Society of Philadelphia*, and to other serials, show clearly his prolific pen, his untiring zeal, and the unusual ability with which he was gifted. His removal from us at a time when he had scarcely more than entered upon the work to which he was devoted is regarded as a loss to science deeply to be deplored.

The publications and official labors of Prof. C. V. Riley — for nine years the State Entomologist of Missouri, for several subsequent years Chief of the United States Entomological Commission, and now the Entomologist of the U. S. Department of Agriculture — have contributed more largely than those of any other person to the extension of our knowledge in applied entomology and its general diffusion. The results of his studies, as given in the nine finely-illustrated Missouri Reports, the Reports of the Entomological Commission, the volumes of the *American Entomologist*, and numerous contributions to various

Fourth Annual Report of the Michigan State Pomological Society, 1875, p. 178.

scientific journals and the public press, have furnished us such a compendium of life-histories of our injurious insects, and means for controlling their ravages, as is possessed by none of the older nations of Europe. It is an honor to American science and a high attestation of the claim made by economic entomology of its utility, that the French Government has conferred upon Prof. Riley a gold medal inscribed with its appreciation of the value of his investigations of the grape phylloxera.*

The four reports of Dr. W. Le Baron, successor to Walsh as State Entomologist of Illinois, published during the years 1871–1874, contain much valuable information upon the insects infesting fruit-trees and other food-plants. The fourth report furnishes an excellent handbook for the classification of the Coleoptera (*beetles*), giving, as it does, synopses of the genera and illustrations of the several families.

Upon the death of Dr. Le Baron, Dr. Cyrus Thomas was appointed State Entomologist of Illinois, and six annual reports have since been published by him. They present the results of his personal studies and investigations, together with those of the assistants with which the State, in appreciation of the work in which he is engaged, have liberally provided him — Prof. G. H. French and Miss E. A. Smith.† As each report is, in the main, devoted to a particular order of insects, as the Coleoptera, Lepidoptera, Hemiptera and Orthoptera, they will be found of eminent service to the general student in entomology who desires scientific knowledge, while they at the same time furnish to the agriculturist the means of recognizing his insect enemies and friends. Dr. Thomas, as a member of the U. S. Entomological Commission, has also rendered excellent service in his studies of the Rocky Mountain locust in its relations to agriculture and the settlement of the Territories. A bulletin upon the chinch-bug, *Micropus leucopterus*, was also prepared by him and has been published by the Commission.

The economic contributions of Dr. A. S. Packard, Jr., have also been quite extensive. They are mainly the following: *Injurious Insects New and Little Known* (1870); the three annual *Reports on the Injurious and Beneficial Insects of Massachusetts* (1871–2–3); portions

*The medal was awarded by the Minister of Agriculture and Commerce of France, "in appreciation of discoveries in economic entomology, and especially of services rendered to French grape culture," and was transmitted, in 1874, through the Agence Consulaire de France à St. Louis. It bears upon its face the head of the Goddess of Liberty in bas-relief, with the words, "Republique Francaise." Upon the reverse is, "Mr. Riley, à St. Louis, Missouri. Services Rendus à la Viticulture Francaise, 1873," encircled by "Ministère de l'Agriculture et du Commerce." (*Canadian Entomologist*, vi, 1874, p. 78.)

†Dr. Thomas resigned his position as State Entomologist in June, 1882, and Prof. S. A. Forbes was appointed in his place.

of the two annual *Reports of the U. S. Entomological Commission; Report on the Rocky Mountain Locust and other Insects in the Western States and Territories;** *Insects Injurious to Forest and Shade Trees;*† *Half Hours with Insects; and, Our Common Insects.* Beyond the above, Dr. Packard's writings in general entomology — anatomical, descriptive, classificatory, and reports on special collections made in various portions of North America — have been very extensive and of a high order. His *Monograph of the Geometrid Moths or Phalænidæ* — a beautiful volume of over six hundred quarto pages and an equal number of illustrations,‡ has added largely to our knowledge of a family possessing great economic importance; while his *Guide to the Study of Insects* has proved a rich boon to the American student, and merits place in the hands of every one who desires a comprehensive acquaintance with the insects of North America.

Prof. J. H. Comstock's labors, as Entomologist to the U. S. Department of Agriculture, have given results of much economic importance, which appear principally in the Departmental Report upon Cotton Insects, 1879, and the Reports of the Entomologist for 1879 and 1880.§ The main portion of the latter report is devoted to a very valuable paper on the common and extremely injurious insects known as scale insects, showing earnest study and extended investigation. An important addition to this report is a supplementary paper by Mr. L. O. Howard, of the Entomological Division of the Department of Agriculture, upon the parasites of the *Coccidæ*, in which many new species are described and the benefit urged that may result from the transportation of the more useful parasites from localities where they abound to those where they may not have been introduced.

The reports of Mr. Townend Glover, Entomologist of the Department of Agriculture from the year 1863 to 1877, contain much material of economic importance valuable for reference, but, from the nature of his duties, not contributing to any great extent in original investigation. In his *Illustrations of Insects*, consisting of 273 plates drawn and engraved on steel by himself, and in the several volumes of *Manuscript Notes from my Journal*, of which small editions have been lithographed for private distribution, he has displayed a zeal for the promotion of science, not surpassed by any American Entomologist. It is much to be regretted that the Illustrations in the Orders of Lep-

*In 9th *Annual Report of the U. S. Geological and Geographical Survey of the Territories*, for 1875, pp. 579-809, pl. lxii-lxx.

†*Bulletin No. 7 — Department of the Interior. United States Entomological Commission*, 1881, pp. 275, figs. 100.

‡Forming vol. x of the Quarto Reports of the *Hayden Survey of the Territories*, 1876.

§Contained in the *Annual Reports of the Commissioner of Agriculture* for the years 1879 and 1880.

idoptera, Coleoptera and Hymenoptera have not, as yet, been published, even for private distribution, as were the other orders — accompanied, as they are, with extended notes collated with much care and industry, and of great practical value. Many of these illustrations, together with their text in manuscript, were exhibited by Mr. Glover at the Entomological Convention held at Paris in the autumn of 1865, and the interest which they excited was attested by the bestowal upon him of the gold medal of the Emperor, as appears in the following extract from the "Documents relating to the Exposition of Insects held at the Palace of Industry, at Paris in 1865:"

"The grand gold medal of the Emperor yet remained to be decreed, and the jury sought to ascertain to whom the high award was due; when, at a late hour, a stranger, an American, Mr. Townend Glover, attached to the Department of Agriculture at Washington, presented himself with a work on practical entomology, applicable to agriculture. This work, comprising, on 130 copper-plates, the useful and noxious insects of North America, belonging to all the orders established by naturalists, coleoptera, etc., is designed and executed by the exhibitor himself from nature, and presents them in their three forms of larva, pupa and perfect insect. To these 130 plates is attached a table with numbers, which refer to the text, and indicate the plants, trees, or shrubs, commonly inhabited by each larva or insect, mentioning the parts attacked, whether the roots, leaves, wood, fruits, grains, etc.; the nature of the damage done, the habits of the insects, the remedies, old and new, to prevent their ravages, and, as far as known, the efficacy of the remedies. These plates have been executed with the greatest care, the insects being represented with exact fidelity to nature. In brief, this work, which has cost the author ten years of research and observation, and for which he well merits the high position he occupies in the Department of Agriculture at Washington, was judged, by an eminently scientific jury, to be original in its style and character, and deserving to be copied by the entomologists of France as a desideratum in the application of their science to agriculture."

Prof. A. J. Cook, of the Michigan Agricultural College, has contributed a number of papers on the natural history and habits of our injurious insects, to the *Reports of the Michigan State Agricultural Society** the *State Pomological Society*,† the *Canadian Entomologist*, etc. The value of several of these papers is enhanced by their containing the results of careful experiments with insecticides and other applications to prevent insect injury, in which he has been aided by his associates in the college and the students under his charge.

Mr. William Saunders, as the able editor of the *Canadian Entomologist* during the past eight years, an enthusiastic horticulturist, and a member of the Special Commission of the Ontario Government for inquiring into the agricultural resources of the Province, has devoted much time to the study of insect pests, and has published upon them many papers of interest and practical importance.

The writings of a number of other of our entomologists deserve

* *Reports of the Mich. St. Board of Agricul.*, xii, for 1873; xiv, for 1875; xv, for 1876; xvi, for 1877; xix, for 1880.

† *Reports of the Mich. St. Pomolog. Soc.*, ii-x, for 1872-1880.

mention in connection with the above notices, but they are distributed among so many of our scientific journals that they cannot be conveniently referred to at this time.

It is announced in a circular of the U. S. Entomological Commission that it has in preparation a full bibliography of the publications in economic entomology throughout the United States, and that it will probably be given in its next (third) volume.* Beyond the great convenience which such a list will afford for the purpose of reference, it will also serve to show the great attention that has been given to this department of study in this country.

The results which we have attained in the investigation of our insect enemies and friends, for there are many of the latter, have been recognized in Europe, and the gratifying tribute has been paid to these labors, that, in the applications of entomology, we are quite in advance of European progress. Our studies have been gladly accepted as serviceable in the advancement of the like work there being carried on. Scientific investigation, of whatever nature, is of world-wide utility, and hence it follows that while the names of Harris, Fitch and Riley are familiar ones in Europe, so the researches of Ratzburg, Curtis and Westwood are aids to which the American student often resorts; and the appearance of a volume, presenting the most approved methods of dealing with European pests, as in the admirable volume recently given to the public, from the pen of Miss Ormerod,† is cordially welcomed by us. But if the applications of the science have made the greater progress in this country, it is but the consequence of the absolute necessity of attention in this direction, from the excessive insect ravages occurring here, as before referred to. In Europe, as the result of a more general study of natural history, the broad recognition of its importance, and the liberal aid extended to investigators through private munificence and government patronage, general entomology has reached a point which we have not approached. There, from the labors of devoted scientists for a century past, the discovery (as I have elsewhere written) of a new insect is comparatively rare. Nearly all the known insects have been described and pictured in accurate figures and faithful coloring, in all their stages, so far as ascertained, even of those microscopic but surpassingly beautiful Tineid moths, whose entire development from the egg to the perfect insect is perfected within the circumscribed limits of a single leaf.

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*That the record may be as complete as possible, all entomologists throughout the United States are requested to aid in its preparation, by sending to the Secretary of the Commission, Dr. A. S. Packard, full lists of their papers on any subject connected with *Economic Entomology* (not general or scientific entomology unless bearing on the applied science), prepared in the style of that adopted in the bibliographical notices of *Psyche*.

†*A Manual of Injurious Insects, with Methods of Prevention and Remedy for their Attacks to Food Crops, Forest Trees, and Fruit.* By Eleanor A. Ormerod, F. M. S., etc., London [1881], 12 mo., pp. 323, many figures.

2. Increased Interest in Entomological Investigations.

The efforts made by our practical entomologists to promote, by their studies, the public welfare, are meeting with a gratifying return, in the growing recognition of their importance, a desire that they shall be continued and extended, and a general disposition to utilize the benefits which they offer. For many years much of the toil of the husbandman has counted for nought. Successive crops have been destroyed or yielded inadequate return, and this was accepted as if it had been blight, mildew, fire, war, or some other calamity which could not be controlled. The recent applications of science have shown that the evil may be greatly lessened, and eager inquiries are now being made how it can be accomplished. From every portion of our broad domain requests are received for instructions how to deal with this or that insect pest, and I doubt if there is one of our prominent economic entomologists who has not been thus addressed from every State in the Union. Many of our agricultural journals have columns specially devoted to the answer of such inquiries. Our agricultural, horticultural and pomological societies are alive to the value of the study, and are asking for the aid which it is capable of giving them; and very properly so, for if such study shall realize the present expectations of those who know its worth, it will further these pursuits, in our country, to an extent which no other science has the ability to do. In compliance with the wishes of the New York State Agricultural Society, officially expressed, the requests of the principal agriculturists in the State, the Board of Regents of the University of the State, and many distinguished citizens in this and other States, New York, foremost in the encouragement of entomological research, has resumed the good work, and provided for its continuance. Other States are moving for the appointment of State Entomologists, among which are California (aroused to the importance of excluding the grape phylloxera from her vineyards, and other of our eastern pests from her fruits), Michigan, Indiana, Iowa, Wisconsin, and Kansas. There is no doubt but that it would be wise economy for every State in the Union to have a properly qualified officer charged with the study of insect injuries and benefits, and that several times his salary would thereby be saved to the State.* Great benefit would accrue from such a number of earnest workers distributed throughout the entire country, extending to one another sympathy and aid, and stimulated to competition in working out the best results. Seldom, then, would it be necessary to make unsatisfactory replies to requests for directions how to arrest some form of in-

*Hon. A. B. Dickinson has given it as his opinion that the New York Entomological Reports of Dr. Fitch have saved annually to the State over $50,000.

sect attack. How is it possible, in view of the fact that entomology, as a science, is but about a hundred years old, and that applied entomology had its birth among us within the life-time of most of those now engaged in its study, to tell just how to deal with every insect of the thousands that annoy or injure us, when of many we even do not know their names, and of most of their number, their habits and transformations in full. By far too much is expected by the public. The small number of workers and the brief time that they have been engaged in their investigations should be considerately borne in mind. Much has been accomplished thus far, as some of the following considerations will show.

3. The Acquisition of Life-histories.

I have already referred to the importance of a knowledge of the life-histories of our insects, the difficulties attending their acquisition, and the long study that they often demand. It is desirable in a scientific point of view that a species should be known in each of its stages, and frequently it is only through a study of the earlier phases that we are able to decide upon the claim of a form to specific recognition. But in the domain of economic entomology, an acquaintance with the larval stage is of paramount importance, as this is the especial period of insect injury. Many of our entomologists are now actively engaged in these studies, under the incentive of a conviction that the student who presents a complete life-history of a single species makes a more valuable contribution than does the discoverer and the describer of a score of hitherto unknown forms. Within the last few years, Mr. W. H. Edwards of Coalburgh, W. Va., has worked out and given us the histories of the larger number of our butterflies east of the Mississippi, and other authors have made us acquainted with the histories of many of our moths. Directions are no longer given for destroying "the cut-worm," for instead of its being a single species to be dealt with in a certain manner, as formerly believed, we now know the moths of nearly three hundred species, which differ so greatly in their habits and transformations that each one needs separate study, and the several groups, greatly differing treatment. Growing attention is paid to the discovery and description of the larvæ of the Coleoptera, commonly known as grubs, and chargeable with injuries equal in amount to those of the Lepidoptera (butterflies and moths). Mr. F. G. Schaupp, of the Brooklyn Entomological Society, has contributed several papers to the Bulletin of the society, describing a number of hitherto unknown forms, and collecting the descriptions of previously described species.*

*See also, Horn, in *Trans. Amer. Ent. Soc.*, vii, 1878, pp. 28–40.

4. Formation of Biological Collections.

Several of our leading institutions have undertaken, and have made much progress in collections illustrative of the life-histories of our injurious insects, by showing them in all their stages in connection with their depredations, and whatever else may serve to present a knowledge of their lives; as for example, if a moth, the egg and shells from which the larva (caterpillar) has emerged; the larva, in each of its 3–6 stages of growth, before and after each molting, preserved in alcohol; larvæ preserved dry, by inflation; larval exuviæ; larval excrementa; diseased larvæ; the pupa; cocoon or ground cell, exterior and interior; pupa-case from which the moth has emerged; empty cocoon; perfect insect in its typical form, varieties, aberrations, monstrosities, etc.; depredations on each of its food-plants; parasites and other natural enemies, etc. When these collections are connected with agricultural colleges and other institutions for promoting agricultural interests, they are usually arranged so as to present for convenient inspection all of the insects connected with a particular food-plant. By this method, rather than by following the order of insect classification, one whose wheat-crop has been attacked by an insect unknown to him, should be able, by consulting the cases devoted to wheat insects, to learn the name of the depredator, and at a glance much of its history, habits and changes. The biological collection of the New York State Agricultural Society, prepared by Dr. Fitch during the latter period of his connection with the Society, was arranged upon this plan. The cases contain the following material: Case 1 — Insects infesting grain and other crops (specifying each principal crop); Case 2 — Grass insects; Case 3 — Insects of the garden (specifying the principal vegetables, flowers, ornamental shrubs, etc.); Cases 4 and 5 — Insects infesting fruit-trees (apple, plum, pear, cherry and quince); Case 6 — Insects injurious to man and animals. About 1600 specimens are contained in this collection, while in another series of larger cases are shown the larger biological specimens illustrative of insect depredations on plants, timber, furniture, and books.*

In the Entomological Division of the Department of Agriculture at Washington, now under the direction of Prof. Riley, the commencement has been made (by Prof. Comstock) of a biological collection which shall, as fully as possible, illustrate the investigations of the Department. It at present contains one hundred and twenty-five cases (double-sided, 31x21 cm.), of which forty-eight are Hemiptera, mainly *Coccidæ*, illustrating the recent Departmental studies of these destructive insects. The collection will no doubt be rapidly extended,

Psyche, ii, 1879, p. 275.

for the liberal appropriations made by Congress for this Division, of $25,000 per annum, is securing for it, through its corps of trained entomologists, a broad range of investigation and a large amount of biological material.

A recent circular ($\frac{3}{1}\frac{9}{8}\frac{6}{8}\frac{6}{3}$, No. 4) of the Smithsonian Institution announces that "Prof. C. V. Riley has deposited in the Museum [United States National Museum] his extensive private collection of insects. The collection comprises some 30,000 species and upward of 150,000 specimens of all orders. * * * * * * The collection is chiefly valuable for the large amount of material illustrating the life-histories, habits, and economy of species, 3,000 of which are represented in one or all of the preparatory states, either in liquid in separate boxes, or blown and mounted dry with the imagines."

Perhaps no one fact may be cited that will better show the progress made in entomology in this country, than that in one of our museums —the Museum of Comparative Zoölogy at Cambridge, Mass., is to be found a biological collection *that has not its equal in the world.* For this we are indebted to the recognition of the great importance of the science by Louis Agassiz, shown in calling to the curatorship of the Entomological Department of the Museum the distinguished European entomologist, Dr. Hermann A. Hagen, and to the appreciation by Alexander Agassiz of the work initiated, in retaining for its successful prosecution the services of the able curator, in the face of unusual efforts to recall him to his former home. The biological collection, which the ability and zeal of Dr. Hagen has brought together and so admirably arranged for scientific study, was based upon extensive European material. To this, large American collections have been added, until it has become wonderful in extent, in variety, in fulness of illustration, with an arrangement permitting of convenience of study and insuring preservation, which it does not seem possible to improve. It occupies, at present, twenty cabinets of eighteen drawers each. Three hundred and fifteen drawers (of 16x19 inches — the size adopted by the principal museums of Europe) are arranged for exhibition and study, while fifty others are nearly ready for incorporation.

The examination of the collection by one qualified to judge of its worth compels a regret that it must forever remain an unique. How it would tend to the diffusion of knowledge could it but be multiplied and distributed for study, like the impressions of a printed page. And yet, the student, who appreciates the superiority of the natural object for purpose of study over any representation of it, and who would best learn what lessons may be taught by the proper assemblage and grouping by a master-hand of even otherwise worthless material, such as deserted tenements, cast-off integumenta, excreta, chips, worm-eaten

leaves and the like, will yield to its attraction, and make his pilgrimage even from the far west, as some have done, to pay his homage to the accumulated treasures of the Entomological Department of the Agassiz Museum at Cambridge.

5. Discovery of Valuable Insecticides.

Another indication of real progress in economic investigation is the knowledge attained within the past few years of several poisons and other substances which may be safely and easily used for destroying insect life. Paris green, which holds foremost rank among our Insecticides, and without which that almost indispensable article of food — the potato — could not be grown in some localities, was first recommended for the purpose in the year 1869, when a correspondent from Wisconsin, of the *Galena* [Ill.] *Gazette*, published the information that the preceding year, with one pound of Paris green mixed with two of flour, sifted through a coarse muslin cloth on the potato tops early in the morning, he had destroyed millions of the beetles feeding on them and obtained a fine crop of potatoes.* Pyrethrum had been used for several years under the names of "Persian Insect powder" and "Dalmatian Insect powder," for the destruction of household pests, but it was not until 1879 that it was shown by Mr. Wm. Saunders, of London, Ontario, by his experiments with it upon grasshoppers and plant-lice, that it could be employed in the destruction of insects infesting our fields and gardens.† London purple was first introduced in the year 1877.‡ It was analyzed by the chemist of the Department of Agriculture the following year and found to contain forty-three per cent of arsenic acid in such association as to warrant experiments with it as a substitute for Paris green.§ The experiments made by the U. S. Entomological Commission were successful and speedily brought the article into popular favor. The prompt action of oils, such as kerosene oil, coal oil and paraffine oil, in destroying insect life, is well known, and experiments are teaching us the best methods of their application without injury to plant-life.

The very great value of several of the popular Insecticides, in an economic point of view, warrants a special notice of some of them.

1. Paris Green as an Insecticide.

The popularity which Paris green has obtained as an Insecticide grew out of the need of some substance (hand-picking and mechanical

American Entomologist, i, 1869, p. 219.

†*Canadian Entomologist*, xi, 1879, pp. 185–6.

‡*Ninth Report on the Insects of Missouri*, 1877, pp. 45–47.

§*Annual Report of the Commissioner of Agriculture* for 1878, p. 144.

gathering having proved insufficient) which could be employed for the destruction of the hordes of the Colorado potato-beetle, which were invading and threatening the entire ruin of every potato field throughout Northern and Middle United States east of the Rocky Mountains and southward into North Carolina and Northern Texas.* It was found that by no other means could this be accomplished so quickly, economically and effectually, and it has, therefore, notwithstanding the popular prejudice against so free an use of a virulent poison, been very extensively resorted to, for several years past, in the cultivation of the potato. It has also been successfully employed in protection from other insect ravages.

Paris green is a combination of arsenic and copper, known in science, as arseniate of copper. In its pure state it contains fifty-eight per cent of arsenic (arsenious acid). The enormous demand for it — druggists in some of the great agricultural centers of the West have ordered it by the ton — and the prevalent disposition to economize in its use by purchasing it at the lowest price, have led to its great adulteration. As frequently sold, it contains less than one-half its proper proportion of arsenic. In using it as an insecticide, it is important that it be obtained pure, for otherwise the directions for its use are not applicable to its altered condition.

It may be used either in its dry form as a powder, or mixed with water or other liquid.

Diluents.— In its dry application, it is mixed with some other material to reduce it to a degree that will admit of its use without injury to the plants upon which it is cast, and of its convenient distribution. The materials usually employed are flour, plaster, finely sifted wood ashes, air-slacked lime and road dust. Care is necessary that it be thoroughly mixed, by long-continued stirring, unless some special contrivance is arranged for the purpose.†

The Dry Mixture.—The best results have been obtained when flour is used, as the compound seems to adhere better to the leaves of plants and to be more readily eaten than are the mineral and other substances. The proportion of flour required will vary with the crop to be protected. Potato leaves will safely bear a pound of Paris green to

*See map of invaded territory, in *Ninth Missouri Report*, p. 36, and estimates of area on p. 38.

† A simple contrivance for the purpose is thus constructed: "It consists of a barrel which has a longitudinal wooden axle projecting somewhat at each end. Five or six staves run through the barrel longitudinally but do not project at either end, and on one side is an aperture large enough to admit the ingredients. When they are in, the aperture is closed and the barrel is placed over a large open box, or fixed in any way so that it can be revolved by means of a handle attached to the projecting axle. (*Bulletin No. 3, of the U. S. Ent. Commis.— The Cotton Worm*, 1880, p. 74.)

twelve of flour, and probably even a less dilution. Other vegetation will show injury to the leaves unless twenty pounds of flour be used, and if desirable to dilute still further for delicate plants, even thirty pounds of flour to one of pure green will destroy a large proportion of insect pests in their early stage. Plaster of Paris as a diluent has the recommendation of its fertilizing properties where uneaten, and of its much less cost. Fifty pounds of it may be used with one of green. A recent statement announces that with a pound of *pure* Paris green thoroughly mixed with from 150 to 200 pounds of plaster, "all the bugs or young, as they appear upon the potato vines [probably having reference only to the newly-hatched larvæ] are readily destroyed." The mixture should be applied in early morning while the leaves are wet with dew, that it may adhere the better.

The wet mixture.—When in liquid suspension, for Paris green is insoluble in water, a half pound may be mixed with forty gallons of water. Double this amount of green, or, in ordinary household measurement, a tablespoonful (a little over an ounce and a half) in a pailful of water (four gallons) is often used on many plants without injury, when more active results are desired. It has been recommended that two or three pounds of flour, first boiled into a paste, be added to the water, or which is more easily done, the flour mixed in a bucketful of water may be set aside until it sours, to save the trouble of boiling.

The liquid application has several advantages over the dry method, as, for example, it is more quickly applied, it gives a more equable distribution, it obviates the danger of inhaling the poison that attends its scattering in the air, and by aid of proper appliances, it can be advantageously used in the protection of our fruit-trees.

Application of the Powder. — The most simple mode is to tie a muslin bag containing the powder to the end of a stick, and to shake it over the plants. A better method, however, and the one usually adopted, is that of a tin box of a convenient size with a cover and having the bottom finely perforated, or covered with wire gauze — the box to be fastened to a stick about three feet long. With this a person can walk along the plants to be dusted, and by gently striking the handle with another small stick, the powder can be uniformly distributed with the greatest care. Boxes made for this purpose and ready for convenient use, similar to that shown in Fig. 6, are to be purchased in our cities and in most of our larger towns. In applying the powder, care should be taken to keep to the windward of the plants to be dusted that it may not be breathed. For poisoning entire fields, numerous other contrivances have been devised and patented, which may be propelled on wheels,

Fig. 6. — Dusting Box, for Paris green.

and are applicable to the protection of the Southern cotton fields. Several of these "Dusting Machines" are described and figured in *Bulletin No. 3, of the U. S. Entomological Commission.*

Cost of the Dry Application.— It is estimated that for the protection of the potato crop, an acre will require three pounds of Paris green and thirty or thirty-five pounds of flour. This, with the green at its usual price of fifty cents a pound, will make the cost of each application, without counting the labor, from $2 to $3. If the beetle is very abundant, and the powder should happen to be washed away by frequent and hard rains, three or four applications, or even more, may be needed during the season.

Application of the Liquid.—When but a few plants or small areas are to be poisoned, no other appliances are needed than a small pail and a brush-broom. With the latter in the right hand, the water, at each dipping, may be sufficiently stirred to hold the green in proper suspension, and the adhering liquid shaken over the plants. When a larger amount of the liquid is necessary, it may be applied with an ordinary watering-pot, provided with a more finely perforated rose than that which commonly accompanies it, which can be made by any tinman. The contents of the pot will require frequent stirring with a stick, to prevent the settling of the poison.

FIG. 7.— SPRINKLER. For distributing Paris green water.

For poisoning on a still larger scale, cans of a large size to be strapped upon the back have been devised, and are for sale in some of our principal cities. One of these, shown in operation in Fig. 7, is thus described in Prof. Riley's Seventh Missouri Report (1875, p. 15) :

"It consists of a can capable of holding about eight gallons of liquid, and so formed as to rest easily on the back, to which it is fastened, knapsack fashion, by adjustable straps, which reach over the shoulders and fasten across the breast. To the lower part of the can are attached two rubber tubes, which are connected with two nozzles or sprinklers. The inside of the can has three shelves, which help to keep the mixture stirred. There is a convenient lever at the bottom which presses on the tubes and shuts off the outflow at will, and two hooks on the sides near the top on which to hang the tubes when not in use. On the top is a

small air-tube and a capped orifice. Two bucketfuls of water are first poured into the can, then three tablespoonfuls of good green, well mixed with another half bucketful of water and strained through a funnel-shaped strainer which accompanies the machine, and the use of which prevents the larger particles of the green from getting into the can and clogging up the sprinkler. Five to eight acres a day can readily be sprinkled by one man using the can, and from one to one and a half pounds of good green, according to the size of the plants, will suffice to the acre. Two lengths of nozzle are furnished, one for use when the plants are small, the other when they are larger. The can should be filled on the ground, and then raised on a bench or barrel, from which it is easily attached to the back. The walking serves to keep the green well shaken, and the flow of liquid is regulated at will by a pressure of the fingers at the junction of the tube with the metallic nozzles. When not in use, the tubes should be removed, and the can emptied and laid upon its back."

When it is desirable to apply the poison to tall shrubs, vines, evergreens or fruit-trees, a forcing-pump is almost a necessity, and perhaps no better one can be recommended for general use than the "Hydronette," manufactured by Messrs. Rumsey & Co., of Seneca Falls, N. Y. It is shown in the accompanying figure.

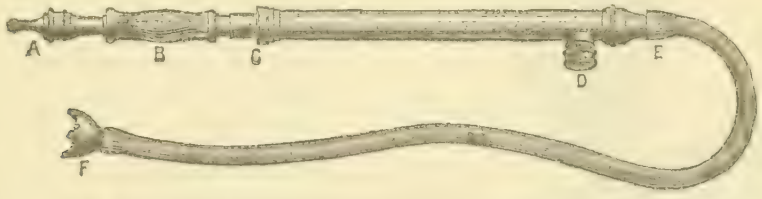

FIG. 8.— THE HYDRONETTE, for the application of Paris green, London Purple, etc.

It consists of two brass tubes, one working telescopically within the other. When the inner tube, by means of the handle B, grasped in the right hand, is drawn outward from the outer tube C, held in the left, the water enters the pump through the rubber hose E, the brass capped end of which is dropped in a pail of water. When the inner tube is pushed back by its handle, the water, being prevented by a valve from returning, is forced outward through the nozzle at A, with such force as to project it to a distance of about forty feet. At D, a rose is represented, which may be unscrewed and substituted in place of the nozzle A, whenever it is desirable to distribute the water in a fine spray. The Hydronette works so easily that it may be used by a boy of eight years of age. A man may hang a bucket of water upon his left arm, and dropping or coiling the hose in it, may apply the liquid as he walks along the plants to be sprinkled. Or, when it is desirable to distribute the liquid uniformly over a field, the tubes may be continuously worked by one person while another carries the pail, and still

another supplies the poison as fast as used. The instrument is made in two sizes, which are sold by the manufacturers or their agents at $8 and $10.

The same Company also makes another force-pump, having the advantage of throwing a continuous stream of water, at the rate of from eight to ten gallons per minute to a height of forty or fifty feet.

Fig. 9.—The Aquaject, for application of mixtures and solutions.

It is known as the "Aquaject," and is sufficiently shown in the accompanying figure, without explanation. Its price, with three feet of suction hose and the same length of distributing hose, with brass discharging pipe and rose sprinkler, is $9.00. Still another form, made more particularly for a fire extinguisher, but by means of a rose which may be procured with it, may also be used for destroying insects, is arranged for standing in a pail of water, where it is held in position by an iron attachment which fastens it to the rim. The catalogue price of this, with pail, is $8.00.

The Whitman Fountain pump, manufactured by J. A. Whitman, of Providence, R. I., which has been extensively advertised, and highly recommended by some of our practical entomologists who have tested its working, appears to be very similar in construction to the Hydronette of Rumsey & Co., and is to be used in the same manner.

In using any of the above forms for the application of Paris green or London purple to apple-trees or other tall trees, it was found that the single stream thrown by the ordinary nozzle could not be distributed over the tree without the consumption of a large quantity of water: if thrown above the tree and allowed to break in drops in its fall, the momentum permitted but a small portion of the poison to adhere to the leaves. With the rose, the water would be scattered in a spray, but only the lower branches could be reached. To obviate these

difficulties, Messrs. Rumsey & Co. have made, at my suggestion, a flattened nozzle pierced with six minute apertures, as represented in Fig. 10, by means of which fine streams can be thrown to the tops of apple-trees, distributing the liquid most economically, and in the form which seems to be the most favorable for the spreading and adherence of the poisons. The nozzle may be applied to any of their pumps, and is to be obtained by application to the Company.

FIG. 10.—NOZZLE, for applying Paris green and London purple to fruit and other trees.

Several more complicated sprinklers have been patented, most of which were specially devised for use in cotton plantations. The U. S. Entomological Commission mention, with more or less full description and illustration, no less than twenty of these sprinklers and atomizers.* The complication of structure displayed in some of these serves to show the inventive talent and mechanical skill called in requisition in order to attain the most practical and economical method of protecting large areas of vegetation, by means of poisons, from insect destruction.

No danger in properly using the poison.— Paris green has not gained its popularity as an insecticide without opposition in many quarters. Several of our scientific men have protested against so free and extensive use of the poison, predicting that grave results would follow. The experience, however, of more than ten years has shown that the apprehended danger has not been, nor will be, realized. It is now believed by those who have given the subject the closest study, that with proper precaution, and in obedience to directions, it may be used with entire safety. The following precautions should always be taken:

The poison should be kept in a safe place and plainly labeled, "POISON."

Do not distribute the powder with the hand, as is sometimes done. An abrasion of the skin might result in serious harm.

Apply the powder with the wind, if any, so as not to breathe it.

Do not use it upon leaves or fruit which are soon to be eaten, or where it will not be washed away by repeated rains (as on cabbage, cauliflower, etc.).

Prevent animals from feeding on poisoned vegetation, and poultry from eating the poisoned insects.

Test the strength of the poison upon a few plants first, lest it may be too strong for the leaves.

Use it of no greater strength than is necessary to kill the insects.

Make such change in crops that its use upon the same ground may not be continued for many years. (Perhaps not important.)

*Bulletin No. 3. *The Cotton Worm*, by Chas. V. Riley, M. A., Ph. D., 1880, pp. 77-97.

There is no foundation for the fear entertained by some persons that potatoes grown from plants treated with the poison are either poisonous or unwholesome. Repeated examinations of such potatoes made by our best chemists have failed to give the least trace of arsenic; and if the potatoes prove watery or appear to be in otherwise bad condition, it may be the result of a diminished foliage of the plants through the insect attack, rather than the poison administered.

Nor can we believe, in view of recorded experiments, that the poison, as it is now being employed, can affect the soil so as to interfere with healthful plant-growth. Prof. R. C. Kedzie, of the Michigan State Agricultural College, has shown conclusively that the arsenic of Paris green does not remain in the soil as such for four months, but before that time it undergoes chemical changes which render it harmless.*

Mr. Wm. McMurtrie, as chemist of the U. S. Department of Agriculture, has instituted a series of very interesting and satisfactory experiments to test the influence of Paris green upon soil and the plants grown therein, which have been published in detail, accompanied with copies of the photographs of the fifteen pots of pease experimented upon and treated respectively with from one hundred milligrams to one grain of the Paris green.† The results obtained were these:

1. An aggregate of 906.4 pounds of Paris green per acre must be applied to the soil before any injurious effects on plant-growth are appreciable [the ordinary application to a potato field is from a pound to two pounds per acre.]

2. Arsenic cannot be absorbed and assimilated by the plant in the economy of growth. All of the plants grown in the arsenical soil, tried by Marsh's test, failed to indicate the presence of arsenic.

3. Potatoes subjected to applications of Paris green failed to give evidence of the presence of arsenic.

The Insects that may be destroyed by Paris Green. — In addition to the Colorado beetle, there are many other injurious species against which this poison may be conveniently used. It would be well, however, not to resort to its aid except in cases where it will accomplish the desired purpose better (convenience, economy and efficiency being considered) than non-poisonous substances.

It may be advantageously used against several other of the potato-insects which occasionally appear in numbers and destructiveness almost equaling the Colorado beetle, as, for example, the three-lined leaf-beetle — *Lema trilineata* (Oliv.), the ash-gray blister-beetle — *Macroba-*

*Quoted in the *Eighth Annual Report on the Insects of Missouri*, 1876, p. 7.

†*Report of the Commissioner of Agriculture* for the year 1875, pp. 144–147, pl. 10.

sis unicolor (Kirby), the margined blister-beetle — *Epicauta cinerea* (Forst.), the striped blister-beetle — *Epicauta vittata* (Fabr.), the cucumber flea-beetle — *Epitrix cucumeris* (Harris), and species of the tortoise-beetles — *Coptocycla aurichalcea* (Fabr.) and *C. clavata* (Fabr.), when numerous.

It would also be useful against the striped cucumber-beetle — *Diabrotica vittata* (Fabr.), and other leaf-eating beetles and their larvæ.

It would be effectual, used in its liquid form with a force-pump, for the prevention of the defoliation of the horse-chestnut, the smaller elms and other shade-trees by the caterpillar of the white-marked tussock-moth — *Orgyia leucostigma* (Sm.-Abb.), which has become such a public nuisance in many of our principal cities.

It has been found to be of great value in preventing the ravages of the spring canker-worm — *Anisopteryx vernata* (Peck), an insect which for some reason, has not occurred as the serious pest in the apple orchards of New York that it has in the Eastern and several of the Western States. With this agent at command, and its efficacy having been thoroughly tested, it is hoped that the threatened increase and spread of the canker-worm in New York may be effectually checked.*

The liquid may be used for the protection of low evergreens from the larvæ of saw-flies and of the basket or bag-worm — *Thyridopteryx ephemeræformis* (Haw.). It should also be available for ridding the Virginia creeper — *Ampelopsis quinquefolia*, from the eight-spotted Forester — *Alypia octomaculata* (Fabr.), and the beautiful wood-nymph — *Eudryas grata* (Fabr.), two prettily-banded blue caterpillars which frequently almost strip the vines in the city of New York and its vicinity.

Paris green would also be an excellent agent for the destruction of the army-worm — *Leucania unipuncta* Haw., applied copiously to the fields where it abounds, or, when it has commenced its marches, to broad strips of grass-land lying in its line of march, and subsequently plowing under the poisoned surface.

In brief, it will be of service whenever extensive depredations occur, not easily controllable by other means, from leaf-eating insects and their larvæ, upon leaves not used for food of men or animals, or only used after so long a period that the poison shall have been entirely washed away, or even upon edible fruit occurring at the time in so

*The following active measures against this pest were employed in the extensive orchard of Mr. Chapin, in East Bloomfield, Ontario county, N. Y., of one hundred and twenty acres: "The canker-worm commenced its inroads, and was worst last year on the interior trees. Mr. Chapin showered them with a mixture of Paris green and water, which brought them dead to the ground in a few hours. The water was drawn in a box holding over two hundred gallons, in which was mixed two and a half pounds of Paris green. A forcing-pump and hose threw a stream high above each tree, where it broke into a spray, and falling, sprinkled every part."— *Country Gentleman*, xliv, 1879, p. 710.

immature a stage or in such condition that it will not permanently retain the poison.

2. London Purple as an Insecticide.

An analysis of a specimen of London purple by the chemist of the U. S. Department of Agriculture gave the following results:*

	Per cent.
Rose aniline	12.46
Arsenic acid	43.65
Lime	21.82
Insoluble residue	14.57
Iron oxide	1.16
Water	2.27
Loss	4.07
	100.00

As appears from the above analysis, it is mainly an arseniate of lime. It is a refuse material, obtained in the manufacture of analine dyes, heretofore worthless. Its cost, therefore, need not much exceed that of package and transportation. Its efficacy in the destruction of insects appears to be about equal to that of Paris green, although it does not accomplish its work so rapidly, for often its effects are not apparent until the second or third day after its application. From the short time that experiments have been made with it, we are not prepared to say that it may entirely take the place of Paris green, yet there are several considerations which seem to give it a greater value as an insecticide than that substance.

Its cost is much less, as it can be purchased at fifteen cents a pound, and at ten cents or less by the keg or barrel. Less than half the quantity is needed. Prof. Riley states that while the cost to the cotton planter of the Paris green material per acre has been one dollar, that of the purple will not exceed five cents.

It is of nearly uniform strength, as its production being much in excess of demand, it does not pay the manufacturer to adulterate it by mixture with any other substance.

As mixed for use it is far less poisonous than Paris green, as is shown from its having been eaten by persons without serious harm.†

It is more adhesive to vegetation and, therefore, not as readily washed away by rains.

**Annual Report of the Commissioner of Agriculture* for the Year 1878, p. 144.

†"I know of two negroes who stole some flour in which it had been mixed in the ordinary proportion for use on cotton, and made biscuits thereof. Both were made sick, but neither seriously. (Prof. Riley in *American Entomologist*, iii, 1880, p. 246.)

Its effects are more permanent, as from its fine state of pulverization it is partially absorbed by the leaves.

The color that it imparts to vegetation shows its application and may serve to prevent the careless use of poisoned plants for food.

In its condition of a very fine powder it admits of a more thorough admixture when used dry, and is more easily kept in suspension in water.

Method of using.— It may be mixed with flour, plaster, or any of the diluents mentioned for Paris green, and dusted upon the vegetation by any of the means there given which may be found the most convenient. When prepared of the strength of one pound of the purple to ten of flour it will injure only delicate vegetation. Reduced with seventy pounds of flour, it will be found to kill nearly all of the leaf-eating larvæ. For general use, the proportion recommended, and which has given the best practical results, is one pound of the purple to forty of flour or other substance.

Its application in water may also be made as directed for Paris green. With one pound mixed with forty gallons of water, some vegetation has been injured. A dilution with forty gallons of water will probably destroy most larvæ. For quite young and more delicate ones, a dilution of one hundred gallons will suffice, and the experiments of the Entomological Commission in the cotton fields have shown that in dry weather and under other favorable conditions, with a pound of the purple mixed in one hundred and fifty gallons, the cotton-worm was readily killed. It should be mentioned that the cotton-worm — *Aletia argillacea*, Hübn., has been found to be more sensitive to the poison than some other larvæ of the *Noctuidæ*. It is, of course, desirable that the poison be not used in greater strength than is needed for killing the species to be destroyed, and the maximum degree of dilution can easily be ascertained by experiment.

The addition of a small quantity of flour to the water will give greater adhesiveness to the poison.

Useful in the destruction of the Apple-worm.— London purple has been used successfully by Prof. A. J. Cook for destroying the apple-worm or codling-moth — *Carpocapsa pomonella* (Linn.). In his recent experiments, continued through two seasons, a tablespoonful was mixed with a pail of water, and this quantity was sufficient, usually, for three trees. It was used in early summer, and the results were very satisfactory, as a large proportion of the fruit was saved from attack. It was believed that the purple formed a thin coating over the fruit and prevented the deposit of the eggs (the eggs are deposited soon after the apple forms), or that the upturned calyces at this time held sufficient of the poison to kill the newly-hatched larvæ in the attempt to

penetrate them to enter the apples. In subsequent chemical examinations of the fruit treated in this manner, no arsenic could be detected, and it was freely eaten by Prof. Cook and his family without any injurious effects. Still, additional experiments in this direction are desirable, before we may give to this method of protecting apple trees unqualified recommendation.

A circular of Hemingway's London Purple Company, 90 Water street, New York, gives the following directions for the use of the purple on potato plants :

"The best method of use is with water. Mix the purple into a smooth paste, and then add water in the proportion of three gallons to each ounce, or forty-eight gallons to one pound. Stir well, and apply by sprinkling with a whisk or fine watering-pot, taking care not to deluge the plants, but only cover with a fine spray. From an economical point of view it is wise to pass it through a strainer. This can be done by tying some cheap cotton-cloth over an iron hoop a little larger than the tub or cask in which the mixture is made, the purple put into the strainer and the water poured over it into the cask, which, as it goes through, will leave behind all dirt or bits of sticks which might otherwise choke up the Fountain pump or other spray-producing instrument.

"If preferred, it may be used dry in the proportion of six pounds of plaster to one ounce of purple, or 100 pounds of plaster to one pound of purple. Mix well by passing the two materials through a sieve. The more perfectly this is done the more certain the effect.

"The proportions given above are the strongest that should be used. If care be taken, a much more dilute mixture may be used with equal advantage."

3. Pyrethrum as an Insecticide.

The Persian and the Dalmatian insect powders are the finely pulverized flowers of species of Pyrethrum — the former of *Pyrethrum roseum* and *P. carneum*, and the latter and the most highly esteemed, of *P. cinerariæfolium*. The Persian powder has been known for a number of years, and the peculiar properties of the powder of some species of Pyrethrum had been utilized even in the past century; but until within the last three years, it had only been employed against household insect pests, as flies, mosquitoes, roaches, bed-bugs, etc. A small quantity of it diffused in a closed room by means of the bellows made for the purpose, acts very quickly upon flies, by bringing them to the floor, struggling upon their backs. They are unable to fly, and if placed upon their legs, they are incapable of using them in locomotion. The powder appears to produce a paralysis from which they rarely recover, although death may not follow until a day or two thereafter. While affecting insects in this manner, it may be distributed in a room as above, and be breathed by persons with perfect safety.

Since the experiments of Mr. Saunders, previously referred to, whereby it was shown that Pyrethrum could be employed against some of our out-door insect pests, other experiments in continuance have been made which have so extended its range of usefulness as to lead us to believe that we have but begun to learn its value as an insecticide. Under the demand which is springing up for it, it is being extensively cultivated in this country, mainly by Mr. Milco (a native of Dalmatia), near Stockton, California, and an article is being produced by him from the *Pyrethrum cinerariæfolium* and sold under the trade name of "Buhach," which is represented by those who have thoroughly tested it, to be superior to much of the imported Dalmatian powder. The high cost of the imported powder (about $1.25 per pound) has been hitherto an obstacle in the way of its use, but Mr. Milco, from the facilities which he has for its production, promises shortly to place it in market at a price which will admit of its general use.

The Department of Agriculture has also shown a commendable zeal in importing the seed and distributing it, through the Entomological Commission, to numerous persons in the United States, with the request that experiments be made in its cultivation in various localities and under different conditions, in accordance with detailed instructions given. It is hoped that some one of the species will be found to admit of such easy culture that it may be grown by farmers and others for domestic use. The circular recently issued by Commissioner Loring contains a statement of Professor Riley, giving a history of Pyrethrum, its method of cultivation, its preparation for use, its uses as an insecticide, and modes of application. From the latter, we extract the following:

Pyrethrum can be applied:—1, as dry powder; 2, as a fume; 3, as an alcoholic extract diluted; 4, by simple stirring of the powder in water; 5, as a tea or decoction.

1. *Application as dry powder.* — It is generally used without diluent, but if unadulterated and fresh (which it not often is, as retailed by druggists), it may be considerably diluted with other pulverized material, without losing its effect. For this purpose flour seems to be the best, but finely-sifted wood ashes, sawdust from hard wood, etc., or any substance that will mix well with the powder, will answer. If the mixture is applied immediately after preparation, it is always less efficacious than when left in a perfectly tight vessel for twenty-four hours or longer before use. Experiments have shown that one part of the powder to eleven of flour were required to kill the cotton-worm, when applied immediately after its application; but when it had been kept in a tight glass jar for about two days, double the amount of diluent (twenty-two pounds of flour) sufficed to kill most of the average-sized worms with which it came in contact. For very young cotton-worms, a mixture of one part of Pyrethrum to thirty parts of flour, and applied one day after preparation, proved most effective, hardly any of the worms recovering.

2. *Application in fumes.*— The powder burns freely, giving off considerable smoke and an odor which is not unpleasant. It will burn more slowly when made into cones by wetting and moulding. In a closed room the fumes from a small quantity will soon kill or render inactive ordinary flies and mosquitoes, and will be found a most convenient protection against these last where no bars are available. Insects of soft and delicate structure are affected most quickly. This method will be found very effective against insects infesting furs, feathers, herbaria, books, etc. Such can easily be killed by inclosing the infested objects in a tight box or case and then fumigating them. The method will also prove useful in green-houses.

3. *Alcoholic extract.*— The extract is easily obtained by taking a flask fitted with a cork and a long and vertical glass tube. Into this flask the alcohol and Pyrethrum is introduced and heated over a steam tank or other moderate heat. The distillate, condensing in the vertical tube, runs back, and at the end of an hour or two the alcohol may be drained off and the extract is ready for use. Another method of obtaining the extract, and a less expensive one, is by re-percolation after the manner presented in the American Pharmacopœia. The former method seems to more thoroughly extract the oil. In either case, the extract is more expensive than the other preparations, though convenient for preserving and handling.

The extract may be greatly diluted with water and then applied with any atomizer. Diluted with fifteen parts of water, it killed all the cotton worms in a few minutes upon which it was sprayed. When mixed in the proportion of one to forty of water, it killed two-thirds of the worms in twenty minutes and disabled the remainder. A dilution of one to fifty still killed some of the worms and disabled others.*

4. *Water solution.*— This method of application is believed to be the simplest most economical, and most efficient. The bulk of the powder is most easily dissolved in water, to which it at once imparts the insecticide principle. No constant stirring is necessary, and the liquid is to be applied in the same manner as the diluted extract. The finer the spray in which it is applied the more economical is its use and the greater the chance of reaching every insect on the plant. Experiments have shown that 200 grains of the powder (about one-half an ounce), stirred in two gallons of water, was sufficient to kill all but the most hardy full grown cotton-worms; but was not strong enough to kill some other larvæ, especially such as are protected by dense long hairs. A solution of one-half of the above strength would destroy young cotton-worms. The solution is most efficient when first made, and gradually loses its power. On the third day it develops a fungoid growth and its efficacy is then much impaired.

5. *The tea or decoction.*— Prof. E. W. Hilgard, of California, who has experimented with the Pyrethrum in this form, thinks that the tea simply prepared from the unground flowers is the most convenient and efficacious method in which it can be used. When sprayed from a fine rose, he found it to be efficient even against the armored scale-bug of the orange and the lemon, which fell off in two or three days after the application, while the young brood are almost instantly killed. Tea made from the leaves and stems has similar although considerably weaker effects. The plants might be grown by the farmer and fruit-grower, when, by simply curing the upper stems, leaves and blossoms all together, the tea

*For a statement of the mode of preparation of the extract and experiments with it upon the boll-worm (*Heliothis armigera*) and the cotton-worm, see the *American Entomologist*, iii, 1880, pp. 252–3.

could be made by the hogshead at a trifling expense, and distributed from a cart by means of a syringe. The tea should be made with briskly boiling water, covered over closely, to prevent evaporation, but not boiled, as that would seriously impair its strength.

While the simple mixture of the powder with water gives such satisfactory results, it hardly seems worth while to look for any other method of using the Pyrethrum, for nothing can surpass this in simplicity. It is only necessary, if the fresh and unadulterated powder can be obtained, to mix a half pound of it in a pail of water and apply it in a fine spray over the young caterpillars, slugs, etc., feeding upon the leaves. The effects upon them are wonderful: they quickly show its operation in writhing and falling to the ground, from which, if the solution is of sufficient strength, they cannot regain the plants, although in some cases, death may not ensue until the following day. If any are found eventually to recover, the solution should be made of greater strength. It must be applied directly upon the infesting insects, as it only acts by contact, and does not have the permanent effect of the poisonous insecticides which are eaten with the leaves.*

The Insects that may be destroyed by it.— Pyrethrum appears to be a very valuable agent for the destruction of the troublesome caterpillars of the cabbage butterfly — *Pieris rapæ* Linn. Its efficacy for this purpose has been recently shown in some experiments by Prof. Cook at the Michigan State Agricultural College. One part of the dry powder mixed with forty parts of flour and dusted over the cabbages, in the latter part of September, killed two-thirds of the caterpillars and stupefied some others. A tablespoonful of the powder mixed with a gallon of water and applied with a common sprinkling-pot to nine cabbages, killed of the larvæ present 17, stupefied 39, and left but 3 alive — the examination being made the following day. From the experiments which were carefully conducted (see *American Naturalist* for February, 1881, pp. 145–147) Prof. Cook draws these conclusions: "they show conclusively that this powder is fatal to the caterpillars, and that, too, in very dilute liquid mixture — 1-200 of a pound to a gallon of water. We have only to sprinkle it on the plants, though it may be necessary to make more than one application to insure complete success. The success was better with the liquid than with the flour mixture and can be applied with greater speed and economy."

Some squash-bugs — *Anasa tristis* De Geer, which had been kept in a close tin box, in the clear powder for three days, were not killed by it. The Colorado potato-beetle can be killed by dusting with the powder, and the larvæ are quite susceptible to it.

I have found the powder ineffectual for killing the harlequin cabbage-bug — *Murgantia histrionica* (Hahn.): it only paralyzed them

*For the peculiar effect of Pyrethrum upon the heart-beat of a caterpillar, see *American Naturalist*, 1882, p. 1015.

for a few hours ; but my material was not fresh and may have been adulterated.

Dusted over house-plants and in the green-house it is said to kill the Aphides (plant-lice) and to preserve the plants from subsequent attack (*Canad. Entomol.*, xi, 1879, p. 42 ; *Amer. Entomol.*, iii, 1880, p. 105).

It has been found to free the Passion vine from the attack of the striped blister-beetle [*Epicauta vittata* (Fabr.)], by stupefying them and causing them to drop from the vines (*Amer. Entomol.*, iii, 1880, p. 193).

It is said to drive away the flea-beetle from turnips and the harlequin cabbage-bug from cabbages by dusting the powder upon the leaves (loc. cit., p. 296).

The powder sprinkled over grain in a mill infested with the grain-weevil [*Sylvanus Surinamensis*], killed them so that they could be swept up by the quart (loc. cit., p. 178).

Hymenoptera (bees, wasps, etc.), are stated to be the most readily affected by the powder. In some experiments made with the fumes upon insects of different orders, they were affected in the following order: ground beetles, locusts, crickets, flies, mosquitoes, gnats — the last yielding most quickly to its influence (loc. cit., p. 195).

The above is but a general résumé of what has recently been learned and published of this very popular insecticide. For those who may desire additional information, references to some of the recent literature upon the subject are herewith given :

Trans. N. Y. St. Agricul. Soc. for 1859 ; xix, 1860, p. 445 (seed sent to the Society); for 1863, xxiii, 1864, pp. 201–2 (general notice).

Rep. Commis. Agricul. for 1877 (1878), pp. 59, 60 (tests of powders of Pyrethrum and other Compositæ).

1*st Rep. U. S. Entomolog. Commis.*, 1878, p. 400 (inefficient on locusts).

Rep. on Cotton Insects, 1879, p. 236 (brief notice).

Canad. Entomol., xi, 1879, pp. 40–43 (kinds, use, effects, etc.); p. 185 (general notice).

Amer. Entomol., iii, 1880, pp. 43–45 (general notice); p. 96 (preparation, etc.); p. 128 (price); pp. 193–195 (effects on different insects); p. 197 (cultivation); p. 222 (for codling-moth); p. 242 (on cotton-worm); p. 246 (properties); p. 250 (effect on different insects); p. 252 (effect on boll-worms); p. 276 (for screw-worms); p. 296 (for cabbage and cotton-worm).

Bull. No. 3, *U. S. Ent. Commis.*, 1880, pp. 62–65 (methods of use, price, etc.).

Proc. West. N. Y. Horticul. Soc. for 1881, pp. 75–77 (kinds, effects, price, etc.)

Amer. Naturalist, xv, 1881, pp. 569–572 (cultivation and manufacture); pp. 744–746 (use and application); p. 817 (applications).

4. Hellebore as an Insecticide.

This insecticide is the root of the white hellebore — *Veratrum album* ground to a fine powder, and used either in this state by sifting it upon

the insects to be destroyed, — by mixing the powder with water, or by a decoction made from the roots by boiling water, and applying it with a sprinkler.

Its insecticidal property was first discovered in England, when it was employed for the destruction of the currant-worm — *Nematus ventricosus* King, in the year 1841. When the same pest was afterward introduced in this country, and had commenced to destroy currant bushes in the vicinity of Rochester, in the year 1858, the hellebore remedy which had been so successfully used in England was resorted to here, and with equal success. Dr. Fitch, in his Twelfth Report on the Insects of New York, writes thus enthusiastically of its virtues:

"Words fail us for suitably expressing the value of this substance. In the whole round of remedies for injurious insects we know of no other one that is so efficacious, we know of no other one that possesses such virtue for destroying any insect as does this substance for destroying this larva [the currant-worm]. It is a sovereign cure for the evil. It is a specific. It operates like a charm. Easy of application and certain in its effects, it is all that can be desired. The larva does not require to eat it. It kills the moment it touches. In the words of R. Lymburn, 'wherever a particle reaches a caterpillar, it collapses as if stabbed,' yes, as if stabbed to the heart. Every one who notices this powder as it falls upon a worm will confirm the literal truth of this statement. The worm is instantly convulsed with a death spasm, rolls off the leaf and drops lifeless to the ground. It is 'a spectacle wonderful to behold.' But if standing on the underside of a leaf where the powder does not touch it, when it afterward comes to eat a particle of it, its doom is sealed with equal certainty."

Methods of use. — In using the hellebore as a powder, dusting boxes such as have been previously mentioned in connection with the other insecticides — a tin can with a piece of fine muslin tied over one end — or even a bag of simple muslin, may be employed. The box or bag should be attached to a short stick, of perhaps two feet in length, to permit of its being thrust among the bushes, and to remove the powder to some distance from the face, as when inhaled in the nostrils it excites violent sneezing; this property has caused it to be employed as the basis of many of the sneezing snuffs. Quiet days should be selected for the dusting, unless its need, when discovered, admits of no delay, as the fine powder is readily carried by the wind: the gentlest breeze that may be stirring will soon indicate to the operator the desirability of the application being made from the windward side. The slightest dusting of the leaves is all that is required. Before using, its strength should be tested by applying a small pinch to the nostrils.

and if it fails to produce a tingling sensation, it should be rejected as comparatively worthless. A pure and fresh article should be purchaseable at about forty cents the pound. This quantity should suffice to keep a garden of ordinary size free from the currant-worm for an entire season — to be applied as often as a fresh hatching or a new brood makes its appearance. With six pounds of the powder, a gardener in England cleared 3,000 gooseberry bushes from the larvæ which were thickly infesting them, by simply dusting them with a large pepper box.

In its liquid application, one pound of the powder may be mixed with from twenty to twenty-five gallons of water, or an ounce and a half (about three tablespoonfuls) in a pail of water, and finely sprayed over the plants. As hellebore kills not only by contact, but unlike pyrethrum, also by being eaten by the larvæ, the addition to the liquid of a small quantity of flour or any other substance that may give it greater adhesiveness, will promote its operating as a protection for a number of days following, from such larvæ as may have escaped the spraying or are subsequently hatched from the egg.

Insects against which it may be used.— In addition to its being a specific for the destruction of the currant-worm, it will probably be found equally efficacious against most of the "saw-flies" as they are popularly called — four-winged insects belonging to the family of Tenthridinidæ, of which the currant-worm may be taken as a representative. Its virtue has been tested upon the strawberry-worm — *Emphytus maculatus*, Norton and Abbot's white-pine worm — *Lophyrus Abbotii* Leach; and it may be expected to operate with equal success upon the Fir saw-fly — *Lophyrus abietis* Harris, Le Conte's saw-fly of the pines and fir — *L. Le Contei* Fitch, and the other species that infest our evergreens. It should also be valuable for use against the saw-fly of the Tartarian honeysuckle—*Abia caprifolium* Norton, which is often so destructive to its foliage. It may also be used for destroying the "slugs" which abound to such an injurious extent upon our rose-bushes, pear-trees and raspberries, viz.; *Selandria rosæ* Harris, *S. cerasi*, Peck, and *S. rubi* Harris. To all of these larvæ the liquid may be conveniently applied by means of a sprinkling-pot, the hydronette or the aquaject. The following method of using the liquid upon rose-bushes has been recommended: one tablespoonful steeped in hot water for ten minutes, diluted in five quarts of cold water, to which a small quantity of soft soap has been added to make it adhere better to the leaves, and applied through a syringe or fine rose of a watering can, while the leaves are still wet with dew. It is said that two applications, three or four weeks apart, will effectually repress the slug each season.

The common poke-weed, *Veratrum viride*, which grows so commonly in wet meadows, should have similar insecticidal properties, but we are not aware that it has been tested for the purpose. Whenever the prepared powder cannot be conveniently procured, this might be resorted to, as a substitute, by making a decoction of it with boiling water.

The following are references to some of the writings which have treated of the insecticidal properties of hellebore:

Fitch's Twelfth Report; in *Trans. N. Y. St. Agricul. Soc.* for 1867, xxvii, 1868, pp. 911, 919, 928, 930.

Canad. Entomol., ii, 1869, pp. 13–15 (effects on currant-worms).

Fourth Rep. Ins. Mo., 1872, p. 14 (useless against Colorado potato beetle).

Ninth Rep. Ins. Mo., 1877, pp. 13–16 (method of use, etc.).

Ormerod's Rep. Inj. Ins. for 1881, pp. 7, 43 (destroys cabbage butterfly larva and pine saw-fly).

5. Kerosene as an Insecticide.

While most of the oils are deadly to insects, kerosene seems particularly so, perhaps from the rapidity with which it spreads over the surface of the insect to which it is applied, at once reaching and closing the breathing pores and producing, through suffocation, speedy death. It is one of the cheapest of the insecticides and is among the most efficient, wherever it can be used without injury to vegetation. In many cases foliage has been injured by its application, and there seems to be justly a prejudice against its general employment, as the statements of experiments made with it are rather contradictory. While it is generally thought necessary to use it only when greatly diluted with water, yet Prof. Comstock reports that he has sprayed it undiluted upon orange leaves and ivy to destroy scale insects, and upon *Crataegus* to destroy the wooly-apple louse (*Schizoneura lanigera*) without the least injury to the foliage. The following testimony is borne to its value in the destruction of a class of insects which are among our most persistent and pernicious pests: "After the failure of many attempts to eradicate this insect [a scale insect infesting a number of imported varieties of orange, lemon, lime, etc., in the grounds of the Department of Agriculture at Washington] the collection may now be said to be entirely rid of it. This has been effected by the persistent use of a small quantity of coal oil [kerosene] applied in water. About one gill of astral oil in five gallons of water applied to the plants through a syringe on alternate days for several months has destroyed the insects without injury to the plants: weaker solutions seemed ineffective, and when the oil was increased to an appreciable degree, the young leaves and tender shoots of the oranges were injured."*

Ann. Rep. Commis. Agricul. for 1878, pp. 205–6.

A difficulty in the use of kerosene and water is found in the readiness with which they separate when at rest, requiring for their union violent and almost constant agitation. In the above applications the mixture was made by discharging the syringe several times into the vessel containing the liquid before each discharge upon the plants. Prof. Riley has announced the following method of overcoming the difficulty and dispensing with most of the attendant labor:

Nothing is more deadly to the insect in all stages than kerosene or oils of any kind, and they are the only substances with which we may hope to destroy the eggs. In this connection the difficulty of diluting them, from the fact that they do not mix well with water, has been solved by first combining them with either fresh or spoiled milk to form an emulsion, which is easily effected; while this in turn, like milk alone, may be diluted to any extent so that particles of oil will be held homogeneously in suspension. Thus the question of applying oils in any desired dilution is settled and something practical from them may be looked for.*

Experiments made by Prof. Comstock do not fully confirm the above statements, as he experienced difficulty in obtaining the emulsions and in their subsequent dilution to any great extent, as appears from the following extract from his last Report:

An emulsion of kerosene and milk can be easily made by placing the fluids together in a bottle and shaking them violently for several minutes; about three minutes is the time usually required. The quantity of milk used should be at least equal to that of the kerosene. The best results were obtained when the kerosene formed only one-third of the mixture, but equal parts of kerosene, milk and water gave as good results as one part of kerosene to two parts of milk. For example, in one series of experiments I was unable to make an emulsion of equal parts of oil and milk, but by the addition of a third part of *either water or milk* I was able in each case to make a good emulsion. These emulsions were of a thick, creamy consistence and were very stable, no indication of a separation of the oil from the milk in one case, or from the milk and water in the other, being observable even after the emulsion had stood for twenty-four hours. But as soon as water was added to the emulsion in any considerable quantity, the oil, or the oil and milk together, floated on the surface of the water; and no amount of shaking would serve to mix the liquid so that the mixture would be stable. It is true that in some of the experiments the emulsion separated from the water less readily than oil alone would; but in each case the mixture was of such a nature that it was necessary to stir it constantly in order to keep the oil suspended in the water.†

In all cases where kerosene can be used without applying it to vegetation it is a very valuable insecticide. It may thus be employed in various methods against a large number of insect pests, as for example:

A small quantity poured in a broad tin basin, either by itself or floated upon water, is serviceable for the collection of the Colorado potato-beetle (where there is an unwillingness to use Paris green and

**Scientific American*, Oct. 16, 1880, and *American Entomologist*, iii, 1880, p. 246.

†*Ann. Rept. Commis. Agricul.* for 1880, pp. 288–9.

London purple), the rose-bug, etc., by shaking them into it; and for destroying nocturnal insects attracted to lights placed in fields.

Cloths may be saturated and spread beneath trees to be jarred. The curculio would be killed by falling upon them, and this method would be of particular value with those insects which show a readiness, upon dropping from the foliage, to take wing or travel away, unlike the *curculionidæ* which usually counterfeit death for a while. A saturated cloth may be stretched upon a light frame and while held in a proper position beside or among infested vegetation, large numbers of the smaller leaf-hoppers, flea-beetles and other minute forms could be driven upon them and destroyed. Or a frame for the cloth could be so constructed as to be pushed by a long handle or drawn by cords over the surface of low-growing crops, by means of which many of these small insects flying or leaping against the cloth would absorb sufficient of the oil, even from the temporary contact, to kill them.

Cattle may be relieved from lice by simply applying the oil in a small quantity to a card, and occasionally carding them with it; its use for a few days will prove effectual (*Country Gentleman*, April 18, 1872, p. 250). It has been used successfully upon horses when the mane and neck have become, through neglect, infected with these annoying parasites, by rubbing it upon them; and upon hogs, by applying it thoroughly with a stiff brush or the stump of an old broom (*Ib.*, March 6, 1873, p. 155).

It is very valuable for henneries infested with lice and mites. Applied to the sides, top and bottom with a sprinkler or, which is better, with the rose of a force-pump, it will effectually destroy the vermin. When the nests of sitting hens are found to abound with a small species of the Acarina, to the extent, at times, of driving the hens from them, a moderate sprinkling of the nest will suffice to kill them and to keep them away. It may also be applied to infested fowls with a feather, to the portions of the body where the vermin are observed. It may even be used with safety upon young chickens, if judiciously employed. In all cases care should be taken not to permit the oil to enter the eyes, nostrils, or mouth.

In addition to kerosene being destructive to insects, it seems to be disagreeable to some species, or at least to prevent their presence. A writer in the *Country Gentleman* states that he has discovered a very simple means of ridding his stables from flies, by keeping the floor free from droppings, and sprinkling it slightly with kerosene by means of a tin can having a small hole pierced in the cork through which a pint of the oil may be distributed in a week's time.

6. Paraffine oil as an Insecticide.

This material has, within the last few years, become a popular insecticide in England, where it is highly esteemed for the destruction of underground larvæ. I am not aware that it has been experimented with in this country, nor do I know if it is manufactured for sale.

The oil is produced by the distillation of Cannel coal. The crude oil gives four products, viz.: 1st, Paraffine naphtha; 2d, Paraffine oil, used as a burning fluid in lamps, in England; 3rd, a heavy oil much used for machinery in Lancashire; 4th, Paraffine used for candles.

When applied to vegetation by sprinkling, in the proportion of one pint of oil to two gallons of water, it has been used with satisfactory results in England for destroying the carrot-fly (*Psila rosæ*), the currant-worm (*Nematus ventricosus*), the onion-fly (*Anthomyia cepurum*), etc. It is claimed that even so dilute a mixture as a glassful of the oil to six gallons of water, and sprayed over the plants two or three times has arrested an attack of the onion-fly; and a wine-glass of oil to one gallon of water has been of service in attack of the carrot-fly.

A plot of young larches nearly destroyed by a species of aphis (*Chermes laricis*) was saved and restored to health, by watering them at intervals of three or four days, for about three weeks, with diluted paraffine, in the proportion of a wine-glassful to a watering-can of water.

An excellent method of mixing the oil is said to be the following: Put the oil first in a pot and then fill in the water vigorously with a syringe. In applying it, one man is kept lifting a syringeful out of the mixture and discharging it into itself, while another applies it to the plant. In using upon tender vegetation, it should be syringed off with clear water in two or three minutes (*London Gardener*).

When mixed with some absorbing substance, as ashes, sand, sawdust, or even dry earth, and applied in this form to the ground, it is more gradually absorbed and is more lasting in its results. Thus one quart of oil to a wheel-barrow of wood-ashes has operated quite beneficially in protecting carrots, turnips, etc., from attack. A convenient method of applying it to plants is to mix with sand just a sufficient quantity of the oil to moisten it, but not to prevent its running readily through the hand, when it may be scattered broadcast or applied directly to the roots of plants. In the absence of rain, sprinkling with water will aid in carrying the oil into the ground. A field of turnips badly infested with the wire-worm (*Agriotes lineatus*), was saved by strewing the paraffined sand with spoonfuls along the center of the drills, so as to fall directly above the roots of the plants,— the whole

crop of four acres being gone over in one day by employing several persons; the effect was thoroughly satisfactory.

The above statement of application and results are drawn from Miss Ormerod's Manual and Reports.

7. Bisulphide of Carbon as an Insecticide.

This material was first brought to notice during the long series of experiments made in France a few years ago, by Government Commissions, distinguished chemists, and others, for the discovery of means for destroying the grape phylloxera. It was proposed to utilize the vapor given off by it in its decomposition when buried in the ground, which should permeate the soil and reach the hidden and sheltered insects among the roots of the vine, more effectually than could be accomplished by liquid poisons as ordinarily applied. In employing it for this purpose, holes to the depth of two or three feet were made in the ground among the roots by a pointed bar, into each of which about two ounces of the bisulphide was poured. Later, an auger was devised to take the place of the bar, having a hollow shank, perforated just above the cutting portion and with an opening at the handle for receiving the liquid. When the auger was withdrawn after the introduction of the liquid, the hole was tightly closed with earth. Very good results attended its use in this manner; and there is no reason to doubt that it would be equally beneficial for destroying other minute forms that infect the roots of growing plants. It should be a remedy for the injuries of the apple-root plant-louse — *Schizoneura lanigera* (Hausm.), — the *Pemphigus pyri* of Fitch, which causes the death of so many apple-trees — of much more common occurrence in the Western States than in New York, where the species is oftener found upon the trunk than on the roots.

Prof. Cook, having experimented with the bisulphide of carbon for destroying the species of Anthomyia infesting our root crops, and some of the root-borers, strongly recommends it for use against the cabbage fly, *Anthomyia brassicæ* (for method of use see page 190), the peach-tree borer — *Ægeria exitiosa* Say, and the squash-borer — *Melittia cucurbitæ* (Harris).

While there are reasons why this material may not come into extensive use as an insecticide, it promises, from its pungent and penetrating odor, to be a valuable agent in protecting plants from egg deposit.

8. Carbolic Acid as an Insecticide.

Carbolic acid has also been used to arrest the ravages of the phylloxera in the same manner as above mentioned for the bisulphide of carbon, and with very good success. Vineyards, through its use, have

been preserved in good condition, while adjoining ones not thus treated have been destroyed.

Prof. Cook has used it, both in its crude state alone, and as combined with soft-soap, for the protection of radishes from the radish-fly, *Anthomyia raphani* (see page 199 where, under the remedies for *A. raphani*, his experiments are given). While the experiments are reported as entirely successful, it does not appear from the account whether the application of the carbolic acid served to destroy the eggs and the larvæ of the fly, or whether it prevented the deposit of the eggs.

I have made use of the acid when quite diluted — one part to one hundred of water, and have recommended its use to others, for ridding potted plants from the small larvæ and worms having their abode in the soil to the great injury of the roots: in all cases when tried, as far as I have learned, the application has been successful.

A correspondent of the *Country Gentleman* (vol. xxxviii, p. 186) commends it very highly for removing vermin from animals.* He used it in the form of carbolic soap prepared by James Buchan & Co., of New York, and by simply washing the hair of cattle with a lather from the soap, he was always able to kill the vermin and the eggs with which they were infested. It also killed those on hogs. A lamb suffering from a bad attack of the "fly," so that a large part of its back and one side was a mass of living larvæ, was cured by two applications of carbolic ointment and lard oil — the oil being used to dilute the ointment so that it could penetrate the wool. At the same time that it killed the larvæ, it also served to prevent fresh attack and to heal the sore. The correspondent concludes his statement of the beneficial effects of the carbolic treatment, with "I know of nothing as valuable to a stock-raiser as the preparations of carbolic acid."

For insecticidal purposes the crude carbolic acid should be used, as being much less expensive than the crystals. It can be purchased of the principal druggists in our larger cities.

9. Soluble Phenyle as an Insecticide.

This material has been brought to the notice of economic entomologists mainly through the experiments reported by Miss Ormerod, of England — made directly by her, or upon her suggestion. It is manufactured in England, under the name of "Little's Soluble Phenyle,"

*The Pediculidæ, or lice ordinarily infesting domestic animals, belong largely to the genus Hæmatopinus. Of these, *H. vituli* and *H. eurysternus* are parasitic on both cattle and horses, often becoming very abundant and of serious annoyance and injury to them. *H. suis*, as its name imports, a large species of nearly one-eighth of an inch in length, occurs on the hog. *H. piliferus* lives on the dog.

where it has been known for some time as a highly valuable disinfectant, deodorizer and antiseptic. It is sold in this country through its general agent, T. W. Lawford, No. 296 East Chase street, Baltimore, Md. It has some of the more valuable properties of carbolic acid, although containing but a very small percentage of this material. An analysis made of it shows that "Phenyle contains 0.79 phenol (carbolic acid) and between eighty and ninety per cent of a high-boiling tar-oil — probably 'dead-oil,' whose most prominent component is naphthaline, and which itself contains little or no phenol. The emulsifier is probably a potash soap or something closely allied."

It appears from Miss Ormerod's Reports that she checked with it an attack of the celery-fly (*Tephritis onopordinis*) by syringing with a very dilute mixture of it and water: others had used, without effect, paraffine-oil and water. A strong attack of the carrot-fly (*Psila rosæ*) was also arrested by its use (Report for 1880, p. 24). It also acted as an excellent preventive of attack, for peas were saved from any injury from the pea-weevil (*Sitones lineatus*) by sowing them in coal ashes saturated with a tablespoonful of phenyle to a gallon of water, the ashes left covered for several days before use to become thoroughly charged with the smell (Report for 1879, p. 8).

It is claimed for this fluid that it will quickly and effectually destroy vermin on sheep, horses, cattle, swine, dogs, cats and poultry. Numerous testimonials to its value in the destruction of the insect pests of animals have been given to the general agent in this country, several of which have been published in circulars (some of them giving the methods of use — degree of dilution of the fluid, etc.) which may be obtained upon application to the agent. As a sheep-dip, for killing ticks and other parasites, it has attained a high reputation, and is being "largely used in all the great wool-growing countries of the world. In Australia it is the recognized dip, and in New Zealand is used at the Government Dipping Stations."

The following directions are given by the agent for its use for Horticultural purposes:

Aphis.— For clearing peach, apple, rose bushes, geraniums, etc., from the aphis, syringe with a mixture of one teaspoonful of fluid to four gallons of water, and syringe with clear water in a few minutes.

Scale on orange trees, etc.— Three, four, five and six teaspoonfuls of the fluid to four gallons of water. Three applications at eight days' interval completely destroy the scale insects. Syringe off with clear water fifteen minutes afterward, more especially if any young foliage is upon the trees.

Ants.—Three spoonfuls of fluid to four gallons of water will destroy these insects.

The claims made for the Soluble Phenyle as an insecticide warrant thorough experiments for testing its value. I have received a package of it, but too late to report any experiments with it at the present time. It may probably be procured in most of our larger cities of prominent druggists. It is put up for sale in bottles, at from twenty-five cents to one dollar each, equal to from three to twenty-five gallons when diluted for use.

10. Coal-tar as an Insecticide.

Dumas, the celebrated French chemist, who was employed by the Government to discover the best means for the destruction of the Phylloxera, experimented with over a hundred substances — most of which were active poisons, and found that the best results were obtained with the sulpho-carbonates and coal-tar.* The latter substance has accordingly been employed in France for destroying the Phylloxera with very good results.

In this country it has been largely employed as a means for catching and destroying the Rocky Mountain locust in several of the Western States. A very simple contrivance was invented for its use, which was known as the Robbins Coal-tar Pan: "A strip of sheet-iron twelve or fifteen feet long is bent up one edge sufficiently to admit of its passing over lumps of earth; other strips, from four to six inches wide, are riveted to the other edge and at each end, forming a kind of scoop. A wire is attached to each front corner of the scoop by which it can be drawn over the ground. A chain or rope is fastened so that it will drag upon the ground about eighteen inches in advance of the machine to scare up the grasshoppers. The inside of the pan is covered with tar, and the machine is dragged across the field against the wind. The efficacy of this simple contrivance is wonderful. One gallon of tar is good for a bushel of grasshoppers when rightly used."

This simple arrangement so satisfactorily accomplished its purpose, giving relief from the fearful locust invasions when nearly all other means had been found ineffectual, that Governor Pillsbury, of Minnesota, undertook to furnish to all parties throughout the State who would make application, immediate supply of the required material, upon understanding of future reimbursement by them. In his Annual Message for 1877, the Governor states: "This offer was promptly accepted, and all available supplies for material having been secured at wholesale, a rigorous war of extermination was maintained simulta-

Annales de Chimie et de Physique, 5e série, vii, 1876.

neously in twenty-nine counties of the State. * * * * * In the prosecution of this enterprise there were employed about 56,000 pounds of sheet-iron and 3,000 barrels of coal-tar, which required a total expenditure of about $10,350."

Another trap was employed in Colorado for destroying the locusts, which is described as "a piece of oil-cloth, nine to twelve feet long and six wide, one side and each end of which are secured to light, wooden strips by common carpet-tacks, the corners being strengthened by braces. The oil-cloth being smeared with coal-tar, the trap is dragged over the ground by two men, a cord about ten feet long being fastened to the front corners for that purpose. The entire expense of the trap is about $3.50."

A still more simple trap has been used with very satisfactory success, by substituting sheets of building paper for the oil-cloth, and coating it with the tar.

For more detailed accounts of these and other coal-tar traps, reference may be had to the *First Report of the U. S. Entomological Commission*, 1878, pp. 387–391.

It is evident that these traps may also be employed for the collection of other low-feeding insects occurring in extensive numbers, especially for the hopping species.

A method of using coal-tar in the irrigating ditches in Colorado may suggest somewhat similar methods for its use elsewhere. "It consists essentially in pouring, or better, in dropping coal-tar on the running water with which the irrigating ditches were supplied. It is only necessary to sprinkle a few drops on the stream, when the oils contained in the tar are diffused over the surface of the water, and coming in contact with the insects (no matter how many), cause their speedy death. The toxic power of coal-tar upon the insects is very remarkable; a single drop of it floating on the water is capable of causing the death of a large number of insects." (*First Rep. U. S. E. C.*, p. 382.)

A convenient method of using coal-tar for the destruction of many of the smaller insects that infest our garden, is to procure a coal-tar barrel with a few gallons of tar remaining in it; fill with water and use from it as needed with a sprinkler. It may be refilled a number of times if the tar be occasionally stirred with a stick to disengage the oil. Used in this manner, it is also a valuable deterrent from insect attack.

It has been stated (*Country Gentleman*, xli, 1876, p. 262), that a gallon of coal-tar mixed with a pound of sulphur, placed in a frying-pan and set on fire, and passed under plum-trees in the morning while wet with dew, every other morning during the curculio season, made

the trees black with the deposited soot, and effectually prevented the attack of the curculio.

Coal-tar, known also as gas-tar, is one of the residual products of gas manufacture. As the result of scientific investigations, these residuals, which were formerly of no value whatever but were simply a waste material, to be disposed of at no inconsiderable cost, have, of late years, become valuable articles of commerce, as they now form the basis of manufactures of great importance. Thus, the corporation of Bradford, England, has lately been offered $50,000 per annum for the ammonia and tar liquids, which eight years previously had been disposed of at a yearly expense of about $4,000 — the former being now almost the only source of ammonia, which has become so popular as an agricultural fertilizer, and from the latter is obtained asphaltum, carbolic acid, cresylic acid, naphtha, the various and beautiful aniline dyes, anthracine, and other valuable products. In this country ammoniacal liquid is seldom utilized. In the vicinity of New York it is employed to a limited extent for fertilizing purposes. Coal-tar is purchasable at a very low price — at the Albany gas-works at $2.50 per barrel. In the Western States, during the large demand for it in the destruction of locusts, its prices ranged from from $3 to $8 per barrel.

11. Gas-Lime as an Insecticide.

The value of this material for checking and for averting insect depredations is recognized among the agriculturists of England, where it appears to be growing in popular favor, as may be seen from the frequent references to it in Miss Ormerod's Manual of Injurious Insects and her later Annual Reports. It has been extensively experimented with, and, for the most part, with quite satisfactory results. For example, it was found, when sprinkled among onions, to check an attack of the onion-fly; it was successfully used against the cabbage-worm (*Pieris rapæ*) by distributing it over the plants, probably both killing the larvæ present and preventing egg-deposit (Manual, p. 37); and applied when fresh to the ground in the autumn as a dressing, and "pointed in" with a few inches of the surface soil, it killed the pupæ of the celery-leaf miner (*Tephritis onopordinis*) lying an inch or two beneath the surface (Ib., p. 60.)*

A refuse material in gas manufacture.— Gas-lime is a refuse material produced in the manufacture of illuminating gas. The common slacked lime, slightly dampened, is spread in numerous shelves of perforated iron in a cast-iron chamber, and as the gas distilled from

*It would doubtless be of equal value, when used in the same manner, against other pupæ lying near the surface, as those of the onion-fly, cabbage-fly, turnip-fly, etc.

the coal is forced through it, it leaves with it its sulphuretted hydrogen and other impurities. It is produced in large quantities by all our gas-works, and, up to the present, it is regarded only as a waste material of no commercial value. As it entails an expense to dispose of it, it would, no doubt, be readily given to any one who would remove it from the works. The Albany Gas Light Company, last year, produced 19,000 bushels, which was carried away by the company and used for filling up some low grounds.

Its value as a fertilizer.—In this country, gas-lime has, within a few years past, been used to some extent as a fertilizer. If its value for this purpose were generally known, and also its proper method of use, there is scarcely a doubt but that every bushel would be reclaimed from waste, and utilized upon lands with quite beneficial results. In reply to frequent inquiries made of one of our leading agricultural journals by correspondents, of its value and method of use, the reply has generally been to this effect: Gas-lime is beneficial to such land as may be improved by the application of common lime. As it is dangerous to vegetation when applied in its fresh state, it should be kept for a year or two, and then fifty bushels may safely be applied to an acre. It may be either made into a compost with two or three times its bulk of swamp-muck, or applied directly to the soil after having been pulverized.

From some experiments made with it during several years, it would seem that it may be much more freely used than above stated and with less caution. A gentleman who claims that he has thoroughly tested its value as a fertilizer, states that two hundred bushels per acre may be safely spread upon meadows and pastures through the winter and up to March 1st, letting the rain wash it into the soil. During the month of February he drew two loads a day fresh from the works, and spread it as it was drawn. (*Country Gentleman*, xlvi, 1881, p. 85.)

Its use, in its fresh state, as an insecticide.—Used as above, in its fresh state, in the latter part of winter, besides its value as a fertilizer, it would unquestionably be of much additional value as an insecticide. It would be destructive to most hibernating larvæ near the surface of the ground and perhaps to the depth that they ordinarily penetrate. The young and less than half-grown larvæ of the vagabond Crambus (*Crambus vulgivagellus*) in their slight protective coverings, would certainly be killed by it. As the latest studies render it probable that the army-worm (*Leucania unipuncta*) in this portion of the United States, usually passes the winter as a caterpillar, sheltered, perhaps, among the roots of the grasses, we should be able to prevent the

excessive multiplication of this pest by the free use of this material. And if we are ever to obtain the mastery of the "white-grub" of the May-bug (*Lachnosterna fusca* Frohl.), so destructive often in grass lands, it seems to me that it is to be accomplished by the use of gas-lime or some very similar product. Experiment could only teach us the proper method and time of its application. We can hardly hope to destroy the pupæ at the great depth at which they are buried, but it may be operative against the young grubs during the first year of their existence. If it should be found that the very early conjunction of the sexes of an allied species (*Polyphylla variolosa*), noticed on page 72, is the general rule among the Lamellicornes, and, as I am inclined to believe, from so extraordinary a development of the generative instinct, that immediately after mating, the earthen ball to receive the egg deposit is shapen by the female and the eggs placed therein, before she takes wing in search of food, then, if as soon as the beetles are seen abroad, the lime be freely applied in as great strength as is consistent with safety, and rain soon follows in sufficient quantity to dissolve out and carry into the soil the poisonous sulphites, the egg-deposits lying just underneath the surface will be reached and killed. If the female requires to be abroad for awhile before she returns to lay her eggs, then the lime meantime applied should serve to prevent their deposit, for reasons given in subsequent pages.

Useful for destroying hibernating insects.— Probably in a large majority of cases where crops have been badly infested with insects which are known to pass the winter in the earth for transformation or simple hibernation, and where the ground is to be prepared in the spring for another crop, a liberal application of fresh gas-lime to the soil at any time between the removal of the crop and near to the time for again planting or sowing, will prove of great benefit.

Useful upon infested crops plowed under.— Whenever a standing crop has become so infested as to render it advisable to turn it under, if the plowing be followed by an application of gas-lime, the insects which have escaped crushing or serious harm in the disturbance of the soil, should be reached by the poison and their destruction completed, while the danger of subsequent attack is greatly lessened. In the many instances in which our economic entomologists have recommended plowing under the infested crop, I would venture to supplement this direction: follow with a liberal application of fresh gas-lime, if it can be conveniently obtained, of perhaps a hundred bushels to the acre. I believe that this would prove the best possible method of arresting severe attacks of the two great clover pests, the clover-seed midge (*Cecidomyia leguminicola*) and the clover-root borer (*Hylastes trifolii*), whenever they occur within easy reach of the gas-works

of our cities. As for any general use for the protection of our farm crops, the supply, at the above rate, would be entirely inadequate, it might be well to economize its use by employing it first against the insects of our gardens.

Its change by age and exposure.— When fresh from the works gas-lime cannot be used in any large quantity upon growing crops without destroying them, as the large proportion (nearly one-sixth) of sulphite of lime which it contains is readily washed out by rain and moisture, and when carried into the soil is destructive to nearly all plant growth. Upon exposure to the atmosphere, the sulphite is changed into the harmless sulphate of lime (plaster). This marked change which it undergoes by age and exposure is shown in the following analyses by Prof. F. W. Johnston :

Composition of Gas-lime.

	Nearly fresh.	Year or two old.
Water and coal-tar	9.59	9.59
Carbonate of lime	58.38	56.41
Hydrate of lime (caustic)	5.92	....
Sulphate of lime (plaster)	2.78	29.32
Sulphite and hyposulphite of lime	15.92	....
Sulphur	0.92	....
Prussian blue	1.80	1.80
Alumina and oxide of iron	3.40	3.40
Sand, etc	1.29	1.29
	100.00	101.81

The length of exposure required to fit it for use upon growing crops may best be learned by experiment. If left until it has parted with nearly all of its sulphurous odor, it will no longer be of special value as an insecticide ; it should, therefore, be tested from time to time and used just as soon as it is found that no harm to the plant follows its application. In many of the experiments made by English agriculturists and gardeners, it had lain from four to six months. In this condition it may be sprinkled directly upon garden plants, even upon cabbages quite advanced in growth, or scattered over the soil, killing the insects without injury to the plants.

Valuable in preventing insect attack.— In addition to its value as an insecticide and as a fertilizer (the latter directly tending through vigorous growth to lessen the losses from insect attack), it may also claim a high order of value in preventing the attack of injurious insects by protecting vegetation from the deposit of their eggs. The operation of this principle will be referred to at some length hereafter.

REMEDIES FOR INSECT DEPREDATIONS.

In the preceding notice of the principal Insecticides, such directions have been given for their use, together with mention of some of the insects against which they may be employed, as should enable any careful person, possessing even a moderate knowledge of the insect world, to use them with safety, with discrimination, and with success, selecting from the number the one which may seem to be the best adapted to the existing emergency, after giving due consideration to the object attacked, the season of the attack, the nature of the attack, and the insect attacking. The frequent inquiries in the pages of our agricultural papers in regard to the use of Paris green, London purple, gas-lime, etc., show, that notwithstanding all that has been published in relation to them, there is still a wide-spread ignorance of their proper methods of use, and an increasing desire for the information which we have endeavored to bring together in convenient form.

It will also be of service to those who are desirous of availing themselves of the knowledge already obtained of the means for the control of insect ravages, to present, in this connection, some of the many remedies and preventives which have been successfully employed for the purpose. Several pages could be filled with them, but those given will serve to suggest others. In the brief form in which they are offered, they may be regarded as a list of weapons serviceable in our warfare with insects, while the skill for their use, the knowledge of how and when to use them to the best advantage, and against what insect foes, may be better learned by experiment than through a long detail of directions — impossible to give in limited space, and necessarily reserved for the discussion of special insect attacks.

The remedies which consist in the use of the insecticides already noticed are omitted. Others, are the following: —

Hand-picking and destroying the eggs: as those of the currant-worm (*Nematus ventricosus*) on the lower leaves of currant bushes, and of the apple-tree tent-caterpillar (*Clisiocampa Americana*) on the leafless twigs in autumn or winter.*

Hand-picking the larva: as the tobacco-worm (*Macrosila quinquemaculata*), the sphinx and other large caterpillars of the grape-vine, etc.

*At a time when the ravages of the caterpillars of the Grape-vine Tortrix, of Europe, *Œnectra Pilleriana* (W. V.), were unusually excessive, it was found that the best means of abating the evil was by picking off the leaves containing the eggs of the moth which were laid in clusters of about sixty each. In one vineyard of one hundred and fifty hectares, thirty persons (women and children) were employed for eleven days in gathering and destroying the egg-clusters; and during this time they collected 1,134,000 of the clusters, representing over sixty-eight millions of caterpillars which would have been produced by them. This method proved so effectual that a decree of Government was demanded compelling the proprietors of the vineyards to perform it annually.

Hand-picking the cocoons: as those of the bag-worm (*Thyridopteryx ephemeræformis*), during the winter when they are so conspicuous as to be readily seen.

Hand-picking the perfect insect: as the rose-bug (*Macrodactylus subspinosus*), when not too abundant.

Jarring trees by pounding on an inserted iron spike, or by shaking and collecting on sheets spread beneath, or on prepared frames; as for the curculio (*Conotrachelus nenuphar*) and the May-bug (*Lachnosterna fusca*).*

Jarring as above for caterpillars that drop by threads when alarmed, and sweeping them upon a rod for destroying: as for the canker-worms (*Anisopteryx pometaria* and *A. vernata*).

Beating the insects from low plants into a pan of water, soap-suds or oil: for those that readily fall when disturbed, as the blister beetles upon potato leaves, the ash-gray b. b. (*Macrobasis unicolor*), the margined b. b. (*Epicauta cinerea* Forst.), the striped b. b. (*Epicauta vittata* Fabr.); and the tortoise beetle on the same (*Coptocycla aurichalcea* Fabr., and *C. clavata* Fabr.).

Collecting the webs of tent caterpillars with their contained larvæ: for the apple-tree tent-caterpillar, and the autumn tent-caterpillar (*Hyphantria textor*).

Cutting off twigs containing companies of social caterpillars, as for the red-humped prominent (*Edemasia concinna*) and the yellow-necked apple-tree caterpillar (*Datana ministra*), on the apple.

Cutting off infested stems and burning: for the currant borer (*Ægeria exitiosa*), the raspberry-twig girdler (*Oberea tripunctata*), and the rose-twig borer (*Grapholitha Packardi?* Zell.).

Crushing between the fingers the shelter of leaf-rollers and leaf-tiers: for the rose-leaf caterpillar (*Penthina nimbatana*) and other tortricids.

*An excellent apparatus for the purpose, convenient for orchards of moderate size, is the following: Take a square of two yards white muslin, or if a larger size is needed for larger trees, make a piece by sewing together, two by three yards, or larger. Stiffen it with light rods across the ends, and with one rod at the middle to keep them apart and to serve as a handle, as shown in the figure. Let it be a little slack, so as to give a slightly concave form to the sheet. Iron plugs having previously been inserted in the tree, or into each main branch, the operator holds this sheet in his left hand under one side of the tree, and strikes the plug with a heavy hammer in his right hand. The curculios caught upon the sheet may be turned into a pan of water and kerosene. Oil-cloth might be substituted for the muslin, as it would not wet with the dew when used in the morning, and as affording a smoother rolling surface for the beetles. (*Country Gentleman*, xlvi, 1881, p. 259.)

Fig. 11. Curculio Catcher.

Gathering and destroying fallen infested fruit: for the apple-worm (*Carpocapsa pomonella*), and the plum curculio.

Probing burrows and killing the grubs with a bent wire or flexible stick: for the round-headed apple-tree borer (*Saperda candida*).

Cutting out the larvæ from tree-trunks: for the flat-headed apple-tree borer (*Chrisobothris femorata*), and the peach-tree borer.

Digging about plants for cut-worms destroying young cabbages (larvæ of *Hadena devastatrix* and *H. subjuncta*), tomatoes (the greasy cut-worm, *Agrotis ypsilon*), and other plants (various species of *Agrotis, Mamestra* and *Hadena.*

Searching with a lantern for night-feeding caterpillars upon grape vines (for *Agrotis cupida**), and upon apple, pear, peach, and cherry trees, for the climbing cut-worm (*Agrotis scandens*), the dark-sided cut-worm (*Agrotis Cochrani*), and others. A sudden jar upon the tree will cause many to drop to the ground when they may be readily noticed and killed.

Attracting to fires of dry wood where it is abundant, or of refuse material from the fields, insects abounding at certain seasons, and known to be readily attracted by light.

Attracting to lamps placed in a vessel of oil or adhesive mixture; as has been done for destroying the cotton-worm moth (*Aletia argillacea*).†

Attracting to poisoned sweets, as molasses and beer (the bait used by collectors in "sugaring" for moths for their cabinets), in which a small quantity of arsenic or cyanide of potassium has been mixed, to be spread on trees, fences, or leaves of plants.

Burning the dead stalks, leaves and other garden refuse in the late autumn to destroy hibernating insects.

Burning stubble in the autumn to destroy the pupæ of the Hessian fly (*Cecidomyia destructor*), unless they are found to contain parasites, when burning would do more harm than good.

Deep plowing in the autumn, to crush or bury delicate pupæ that lie near the surface.

Ditching to collect "marching" caterpillars, as of the army-worm (*Leucania unipuncta*), and in the Western States the chinch-bug (*Blissus leucopterus*).

Barricading with boards coated with coal-tar to prevent migration from one field to another.

Pouring tar upon the ground along the exposed sides of fields to serve instead of boards to arrest migration.

**Thirtieth Rep. N. Y. St. Mus. Nat. His.*, 1878, p. 236; Lintn. *Ent. Contrib.*, iv, 1878, p. 124.

†In Bulletin No. 3 of the U. S. Entomolog. Commis., on the Cotton-worm, are given notices of ten different lamps, of which some are movable on wheels for drawing through the fields, with illustrations of several of them.

Rolling the ground to pack it and render it more difficult for root-attacking insects to enter the ground for the deposit of their eggs.

Applying benzine in floor-joinings near the walls and beneath the base-boards of rooms to kill the carpet-bug (*Anthrenus scrophulariæ*).

Sprinkling with hot-water, of a temperature of from 130° Fahr. upward; for the cabbage-worm (*Pieris rapæ*), and many others.

Sprinkling with lime water will destroy many of the more tender insects.

Sprinkling with alum water — one pound of common alum dissolved in three gallons of rain-water, is stated to be effectual in killing cabbage caterpillars, and the currant-worm.

Sprinkling with copperas water is destructive to many of the smaller caterpillars that feed on shrubbery and garden plants.

Sprinkling with sulphuric acid water — one part of acid to fifty of water — is effective and safe on hardy plants.

Sprinkling with a weak solution of blue vitriol (sulphate of copper) — one ounce to a pail of water — kills many kinds of larvæ.

Sprinkling with an infusion of quassia — three pounds to a barrel of water — is recommended for killing cabbage-caterpillars, and preventing subsequent attack.

Sprinkling with a solution of soft soap and carbolic acid; for plant-lice on rose-bushes, etc.*

Sprinkling with a solution of one pound of whale-oil soap in one gallon of water, for insects infesting rose-bushes. A solution of this strength should after a few minutes be washed off with water.

Sprinkling with tobacco water is an excellent remedy for many insect attacks, from its poisonous nature.

Watering copiously, at nearly the boiling point, for killing the peach-tree borer.

Watering with ammoniacal liquor from gas-works will kill many larvæ attacking root crops.†

Dusting with air-slacked lime; for the larvæ of the asparagus beetle (*Crioceris asparagi*), the larvæ of the grape-vine flea-beetle (*Graptodera chalybea*), and other similar Coleopterous larvæ.

Dusting with air-slacked lime and carbolic acid — a tablespoonful of

*Take of the crude carbolic acid one part to ten of soft soap, and after mixing it thoroughly, let it stand for a few hours. Test the mixture by stirring a little in soft water. If oily globules of the acid float on the surface add more soap to the mixture, and do so until the globules no longer appear. Dilute the mixture to a moderately strong solution, with which sprinkle the infested plants. If the plants are delicate they will need to be washed off in a few minutes, otherwise the solution may remain to serve as a preventive, for some time, from another attack.

†A severe attack upon cabbages and cauliflowers was arrested by three or four applications of this liquid, diluted with twice its quantity of water and poured upon the soil directly around the stem of the plants (*Miss Ormerod's Report on Injurious Insects, for* 1881, p. 8).

the acid to a quart of lime: said to be effectual against the striped flea-beetle, *Phyllotreta vittata* (Fabr.), infesting the turnip, cabbage, radish, mustard, and many cultivated flowers, such as candytuft, sweet alyssum and most others belonging to the order *Cruciferæ*.

Dusting with soot: recently recommended as quite as destructive to the currant-worm as hellebore; it may be questioned whether it can operate as quickly.

Dusting with wood-ashes: of greater value when applied to vegetation that will hold it for percolation by rain and dew, for gradual penetration to the attacked portions.

Dusting with road dust or any other fine material that will readily adhere to a viscid surface, like that of the cherry and pear slug (*Selandria cerasi*), closing the breathing pores.

Showering a solution of soap by means of a force-pump: for killing scale insects upon the trunk, branches, and leaves of trees.*

Showering fish-brine upon trees infested with scale insects has been quite effectual in experiments with it — the oil with which it is charged doubtless penetrating the scale and killing the eggs beneath.

Smoking with burning tobacco confined by a vessel or tight bag over house-plants for fifteen minutes, for scale insects.

Watering with mustard water — a tablespoonful of mustard to a gallon of water; for soil of potted plants infested with worms and the larvæ of small flies.

Spreading soot upon the ground over the roots of plants in gardens attacked by small insects, and sprinkling occasionally with water.

Pasturing sheep in orchards to feed on fallen fruit: for the apple-worm of the codling-moth, and the apple-curculio (*Anthonomus quadrigibbus* Say).†

*Prof. Comstock, who, in the course of his special studies of the scale insects (see Report of the Entomologist of the U. S. Dept. of Agriculture for 1880), has been experimenting extensively upon methods for their destruction, recommends a strong solution of soap as preferable to any other substance, so far as known, for killing them without harm to the tree. The solution, in his experiments, was applied to some orange-trees infested with the red scale of California (*Aspidiotus aurantii* Maskell), of the strength of three-fourths of a pound of whale-oil soap to one gallon of water, with the result of killing all the insects upon the tree. A solution of half the above strength left only a few of the insects upon the leaves alive. As the result of all the experiments made, one-fourth pound of soap to one gallon of water is recommended — the application to be repeated after a few days. (*Ann. Rep. Commis. Agricul.* for 1880, pp. 286–7; Id., *Proc. West. N. Y. Horticul. Soc.* for 1882, pp. 41-2).

†Sheep, in orchards, are also of much service in the prevention of insect injuries, by the more healthful condition of the trees through fertilization of the soil, not only by their manure but largely from the quantity of the soluble salts of potash (estimated at one-ninth of the weight of the fleece in the grease), which, as it is washed out by the rains, gives to the soil an element which is almost indispensable in successful orchard culture. For a statement of the benefit of sheep pasturage in an orchard, see *Report Commis. Agricul.* for 1873, pp. 405–6.

If the trees are young and the bark smooth, they may need protection from the sheep.

Employing swine to root for grubs in grass lands, for the white-grub (*Lachnosterna fusca*), and in orchards for the spring canker-worm (*Anisopteryx vernata*).

Employing a flock of fowls to feed upon the asparagus beetle (*Crioceris asparagi*).*

Placing coops of young chickens in gardens to feed upon the numerous small beetles, such as the flea-beetles, and other insects infesting garden vegetation.

Protecting and encouraging such insectivorous birds as are found by the recent studies of Prof. Forbes, and others, to feed principally upon *injurious* insects.

Levying a war of extermination upon that unmitigated nuisance, the English sparrow (*Passer domesticus*), to which we owe, in the city of Albany and many of our other cities, a great increase of the caterpillars of the white-marked tussock-moth (*Orgyia leucostigma*) which defoliate our shade trees, and of other injurious hairy caterpillars.

Protecting the skunk for the service it renders the hop-grower in discovering and destroying the "grub" attacking the root of the hop-vine; and for the many other injurious insects which it feeds upon.†

Domesticating toads in gardens (the large common species, *Bufo Americanus*), where they are such successful nocturnal collectors of beetles, that entomologists have pressed them into the service of collecting for their cabinets. The stomach of one examined was found to be nearly filled with flea-beetles of a species abounding on cabbages and turnips in a garden.

Colonizing lady-bugs (the *Coccinellidæ*), on house plants and other vegetation infested with plant-lice.

Collection of parasitized insects and carrying them to localities where the parasite has not occurred.‡

*Fitch: *6th to 9th Reports on the Insects of the State of New York*, p. 186.

†*Report of the Commissioner of Agriculture*, for 1863, p. 268; *Country Gentleman*, xlii, 1877, p. 52.

‡This is quite practicable, and was accomplished by Dr. Le Baron, while State Entomologist of Illinois, who collected at his home in Geneva, in the southern portion of the State, a package of apple-tree twigs infested with the bark-louse (*Mytilaspis pomicorticis*), which were largely parasitized with the eggs of its parasite (*Aphelinus mytilaspides*)—a minute Chalcis fly. The twigs were sent into the extreme northern portion of the State, to Galena, where the same bark-louse abounded, but was entirely free from parasitic attack. Here they were tied to the branches of infested trees. On the second year thereafter, the presence of the parasites was discovered in many of the scales of the bark-louse examined at Galena, leaving scarcely room for doubt that the experiment had proved successful, and that the parasites had been introduced by means of the twigs sent for the purpose. The experiment, in view of the incalculable importance of parasitic aid in controlling insect depredations, may justly be regarded as "one of the most admirable instances on record of the triumph of science in its application to economic entomology." See Le Baron's *Third Ann. Rep. Ins. Ill.*, 1873, pp. 200–202.

Washing with tobacco, 16 pounds; oil of tar, 3 pints; soda-ash, 20 pounds; soft-soap, 4 pounds: for sheep (sufficient for a flock of fifty) infested with ticks (*Melophagus ovinus*).

Washing with "Sheep Dip," sold by Messrs. Kidder & Laird, 83 John street, New York, agents for James Buchan & Co.'s Carbolic Soaps, etc., for freeing from ticks.

Anointing with Cresylic Ointment, sold by the above firm, for destroying the "screw-worm" — very destructive to living animals and occasionally to persons in the Southern and Western States.*

Anointing with sulphur, lard, and kerosene, on the head and beneath the wings of fowls infested with vermin.

Suspending a thin muslin bag containing washed sulphur from the top of the cage of canary birds in position that it may be occasionally struck by the birds; for killing the mites (*Dermanyssus avium*) that infest caged birds.

Washing infested places with corrosive sublimate dissolved in alcohol (one-half ounce to one pint), for destroying bed-bugs (*Acanthia lectularia*).

Attracting to a paste of molasses and red-lead; for poisoning the cockroach (*Stylopyga orientalis*) and the Croton-bug (*Ectobia Germanica*).

Attracting to a mixture of molasses and London purple; for destroying the large black ant (*Formica Pennsylvanica*), which occasionally infests dwellings.†

Attracting to a sponge saturated with sweetened water, the little red ant, and when well filled, dropping in boiling water.‡ If very abundant, repellants are preferable (see page 65).

Attracting to a lighted candle in a basin of water on the floor of an infested room, at night, for fleas (*Pulex irritans*).

Trapping in a glass of soap-suds covered by a piece of card-board with a small central opening and covered within by molasses, honey or other sweets; for house-flies.

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*The fly, which is believed to be a species of *Lucilia*, deposits its larvæ on blood or bloody living flesh, and in seasons of great abundance, also on meat exposed in markets. See *American Entomologist*, iii, 1880, pp. 21, 203, 275, 276.

†A house infested by this insect was entirely relieved from its presence in a single night by removing all food from the pantry to which the ants were accustomed to resort, and placing in it a saucer of maple syrup in which was thoroughly mixed a teaspoonful of London purple. The saucer, for hours, was blackened with the congregated ants, and the following day, their dead bodies were thickly strewn along their trail. Not an ant was thereafter seen in the house (*Country Gentleman*, for June 22, 1882, p. 501, col. 4).

‡This species, which has become so great a pest in many localities, is known, according to our best authorities, as *Monomorium Pharaonis*. It is the *Myrmica molesta* of Say. It is a cosmopolitan — is found everywhere in Europe, and has no doubt been very generally distributed through commerce.

Attracting, for pupation, the larvæ of the apple-worm to paper bands placed about the trees, from the latter part of June to their disappearance, — the bands to be examined at intervals of about ten days for the removal and killing of the pupæ.

Attracting nocturnal feeders to shelters of pieces of wood, bark, chips, leaves, bunches of freshly-mown grass, placed in gardens; for the curculio, squash-bug (*Anasa tristis* De Geer), the harlequin cabbage-bug (*Murgantia histrionica*) in the South, for cut-worms, etc.

Attracting to baits of sliced potato or other vegetables buried beneath the ground in gardens, upon the end of a stick for convenience of examination; for wire-worms (larvæ of the *Elateridæ* or snapping beetles, *Melanotus communis* Sch., etc.).

PREVENTIVES OF INSECT DEPREDATIONS.

Our more accurate writers in economic entomology, in the recommendations which they present for the arrest of insect depredations, have, of late, made a very proper distinction between *preventive* and *remedial* measures. If we construe an "insect attack" in its broadest sense, as a habit pertaining to a species of insect, of regularly attacking a plant or an animal, then its arrest at any time or in any manner may properly be regarded as a remedy of the evil, and remedial measures would thus comprise preventive ones. But if we limit the "attack" to each separate periodical recurrence of the same, then it is possible by the interposition of preventives to preclude the attack and to render remedies unnecessary, and, indeed, impossible. In this latter sense, "remedies" imply that an attack has commenced; "preventives," that means are resorted to prior to the commencement of attack.

Of the latter are such measures as the following :—

High culture, to impart strength to resist insect attack, by proper preparation of the soil and employment of fertilizers.

Rotation of crops and their removal as far distant as possible from the soil which has become infested with their attacking insects.

Selection of seed less liable to attack: thus it is claimed that the Hessian fly has not been found in Lancaster nor Fultz* wheat (*Bull. No. 4, of U. S. Entomological Commission — The Hessian Fly*, p. 29).

Refraining for a year or two in an infested locality from the cultivation of crops formidably attacked.

Late sowing: for the Hessian fly, after the first frosts occurring about the 20th of September in New York.†

*Originating near Allenville, Penn., from three tall stalks bearing peculiar looking heads, picked by Mr. Fultz in 1862, in a field of broken-down and tangled Lancaster red wheat (*New York Weekly Tribune*, for Jan. 17, 1883, p. 11, col. 2).

†The wheat seeding in New York last year (1881) extended from August 15th to October 30th, averaging September 16th (*Special Report* — No. 42, *Dept. Agriculture*, p. 5).

Surrounding fields with a border or traversing it with rows of a more attractive food-plant to concentrate the attack, and perhaps permit of the destruction of the insect in its early stages.

Encircling trees near the base with a strip of freshly-tarred cloth (six to ten inches wide), the tar to be renewed as often as it becomes dry, to prevent the ascent of the wingless moths of the canker-worms.

Encircling trees with the canker-worm trap, made of a tin band and a muslin supporter, described and illustrated in the *Register of Rural Affairs*, vol. vii, p. 189,* and shown in fig. 12.

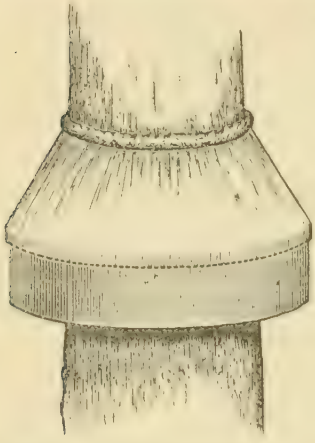

FIG. 12.—CANKER-WORM TRAP.

Washing trunks of trees and larger limbs with soft-soap to prevent egg-deposit: for the apple-tree borers (*Saperda candida* and *Chrysobothris femorata*), the peach-tree borer (*Ægeria exitiosa*), etc.

Mounding with earth or ashes about the base of peach trees, adding a few inches each year, to prevent the egg-deposit of the peach-tree borer (see 1st *Missouri Report*, pp. 48–49).

Wrapping a piece of stiff paper around the roots of cabbage and tomato plants when transplanting, reaching to, or just above, the surface of the ground, to protect from the cut-worms that cut the stem near the surface.

Encircling tree-trunks with a band of loose cotton batting, to prevent the caterpillars of the white-marked tussock-moth (*Orgyia leucostigma*) in their travels for food from ascending the trunks of horse-chestnuts, elms, etc.

Spreading strips of roofing paper (prepared with gas-tar) of about two feet in width, beneath the border of carpets, to prevent attack of the carpet beetles (*Anthrenus scrophulariæ* and *Attagenus megatoma*) and the carpet-eating moth (*Tinea pellionella*).†

Spreading strips of paper saturated with printers' ink, as above, for the same purpose.

Encasing in paper bags, as early as the month of May, small woolen articles to protect from the *Anthrenus*, *Attagenus*, and *Tinea*; also,

Pinning in sheets (linen preferable) and with edges turned over, articles too large for convenient bagging, after placing in their folds shavings of red cedar, scraps of Russia leather, spices, ground pepper or camphor: also,

*Also in 8th *Rep. Ins. Mo.*, 1876, p. 20; 6th *Rep Mich. St. Pomolog. Soc.* for 1876, p 42; *Country Gentleman*, xlvii, p. 393.

†The only "clothes-moth" known in the United States, the larva of which constructs a case for its occupancy. It feeds indiscriminately upon all kinds of woolen clothing, carpets, furs, feathers, etc. (FERNALD, in *Canad. Entomol.*, xiv, 1882, pp. 166–169.)

Tobacco dust for protecting such large articles as those referred to, and carpets rolled up during the summer.*

Sprinkling powdered borax near the base-board or wainscoting of basements, to repel the cockroach and the Croton-bug.

Washing, with strong alum water shelves and other infested places; for the above insects.

Drawing a broad line of chalk about the border of a shelf or around dishes upon it, for the red ant. Pennyroyal, and sassafras bark and roots, are also said to repel it.

Imbedding the lid of stone jars of pickled fruit in paper charged with tar-water or carbolic acid; for the pickled-fruit fly (*Drosophila ampelophila*).

Pinning naphthaline, prepared in cones for the purpose, by C. A. Blake, of Philadelphia, in cases and drawers of insect collections: for the museum pest (*Anthrenus varius*) and the minute *Psocidæ* (*Psocus domesticus* and *Atropos divinatorius*, Fabr.).†

Washing with a camel's-hair brush the dried plants in a herbarium with a preparation consisting of corrosive sublimate, four drams, sulphuric ether, three ounces, mixed; to which add two ounces of spirits turpentine and three ounces of alcohol. (Used in the N. Y. State Collection.‡)

Showering plum trees with a solution of putrid whale-oil after each rain, commencing with the falling of the blossoms, has protected from the curculio. (*Country Gentleman*, xli, p. 310.)

Soaking the seeds of turnips and onions in spirits of turpentine to prevent the attack of the larvæ of the Anthomyian flies, has been recommended and may be tried, but it is of doubtful utility.

Manuring with spent hops has been found of service in cabbage-growing districts as a preventive against the attacks of the cabbage-gall weevil and other pernicious insects. (*Manual Inj. Ins.*, p. 44.)

Tansy tea: made strong by boiling the leaves in sufficient water to cover them, and applied through the rose of a sprinkling pot, has protected bearing cucumber vines from the flea-beetle (*Epitrix cucumeris*, Harris), and cabbages from caterpillars.§

*B. Payn & Son, Tobacconists of this city, inform me that the sale of this material to dry-goods merchants, for the protection of woolen fabrics, to furriers, to livery-men for protection of carriage robes, to gardeners for destroying insects, and to others for household uses, etc., have amounted to four and five tons per annum.

†If it is desired to keep the preparation on hand, the State Botanist suggests that the ether might be omitted without materially impairing its efficacy.

‡This preparation is said to be injurious to collections of Lepidoptera, producing greasing, etc. (See *American Naturalist*, xvi, 1882, p. 410.)

§A correspondent of the *Country Gentleman* states that he has saved his plants for two years by steeping tansy and pouring it upon them after they began to head, only two applications proving to be necessary. When the moths (*Plusia brassicæ*)? commenced depositing their eggs, he gave the plants a dose every two weeks, and no injury by caterpillars was subsequently seen.

A NEW PRINCIPLE OF PROTECTION FROM INSECT ATTACK.*

It will readily be conceded that the use of preventives, whenever practicable, is more economical, more effective, and often more convenient than a resort to remedies. An old familiar adage affirms this truth, when it asserts that "an ounce of prevention is better than a pound of cure."

It has been claimed by some of our economic entomologists, that the most valuable methods of prevention are to be found in the husbandry that tends to promote healthful and vigorous plant growth, imparting strength and vitality which will greatly lessen insect injury, and in the clean culture which shall remove from the garden, orchard, and field, valueless harborage and protection for insect hibernation and transformation.

The results of recent experiments with various substances in the effort to find those that shall best enable us to control insect depredations, have led me to believe that we have, within our reach, still more valuable preventives than the above, in certain substances, which, applied to the soil, or to the plant directly, shall furnish us *a safeguard against the deposit of insect eggs.*

The great benefit of commencing our efforts at this point is so obvious as to need no words to commend it. It would not be "nipping in the bud," or "crushing in the egg." It is prior to and beyond these. If no egg be deposited, we have no artfully concealed egg to search for; no larva, whose rapacity and destructiveness we must arrest; no pupa, whose retreat is to be discovered, and no imago, whose egg-distended abdomen is fraught with evil, to be captured or entrapped — in short, we have dispensed with the four insect stages that require such unwearied and unending investigation in order to ascertain the most vulnerable point of attack of insect life, and the best means with which to assail it.

How may the deposit of eggs be prevented. — It may be prevented by applying to the plant or to the soil certain odorous substances which are popularly believed to be disagreeable to the insect, and therefore, to drive it away. Such substances have been termed "repellants," but we doubt that they exert a repellant force, and we believe the name to be a misnomer.

Among these substances may be mentioned kerosene oil, coal-tar,

*The following pages in which this topic is discussed have already been published in the *Proceedings of the Western N. Y. Horticultural Society*, 1882, slightly modified in some portions to adapt it for presentation as a Society paper. The new views advanced are not offered as proven truths. They have been but recently conceived, without the opportunity of maturing them or of submitting them to the varied tests by which they should be tried, and therefore, they can only claim, at present, theoretic value.

naphthaline,* carbolic acid, gas-lime, and bisulphide of carbon. That these and similar substances have been successfully used in preventing insect attack is undeniable, resting, as the claim does, on the authoritative testimony of some of our best writers and experimenters in economic entomology.

How do they prevent egg-deposit — They do so, by giving out an odor overpowering that of the plant (or animal), thereby preventing its recognition by the insect.

For the acceptance of this proposition, it is necessary also to accept the following: Insects, as a rule, are guided in the deposit of their eggs, not by the sense of sight, but by that of *smell*. A somewhat extended consideration of this view seems desirable, before proceeding to its practical application. The idea is a popular one, that most of the moths and beetles, and many of the insects that attack vegetation, select by means of sight the particular plant upon which to place their eggs. Their marvelous compound eyes, consisting of hundreds and even thousands of separate lenses, even to the number of 34,000, as in the eye of the butterfly, have been cited as a wonderful provision in nature, to afford that acuteness of vision which was needed in their selection of the proper plant upon which to oviposit. While sharing in this belief, I had often wondered at the incomprehensible acuteness shown by an insect in the discovery of the particular species of plant upon which alone the young caterpillars proceeding from its eggs could feed, — in the discovery of a single individual of a rare species occurring in a certain locality, and growing in such a manner as effectually to hide it from human observation. When its range of food-plants extends beyond a species to all the members of a genus, how could it detect all of the often greatly differing forms? When a still broader range embraces the several genera of an extended order, a still greater variety of forms are presented, which the rude insect brain must group and classify, and claim within its province. How amazing such knowledge without previous instruction. It had no parents living, as in the class of vertebrates, which might teach it by example. It had no ancestors a whit wiser than itself from which to learn. The deposit of the egg in its proper place may have been but the second voluntary act of its imago life, regarding that of flight for the purpose as the first. Perhaps a plant from some distant shore, of which not one of its ever so remote ancestry could have had any knowledge, is

*Naphthaline is one of the products of the distillation of coal-tar, which, together with the other two products, anthracine and benzole, is largely employed in the manufacture of aniline colors. One hundred pounds of coal-tar gives from six to eight pounds of naphthaline, from one-fourth to one-half pound of anthracine, and from two and one-half to three pounds of benzole.

brought within its range of wing; its flight is unhesitatingly directed to it, and its precious burden of eggs, without a shadow of mistrust, is at once committed to its leaves. Such knowledge has never been attained by our most distinguished botanists, and it is beyond the scope of human intellect. We have called its displays instinct — a word conveniently framed to cover manifestations in other classes of animated beings, which we are utterly unable to explain. As a partial explanation of these wonders, it has been suggested that to the insect world may have been given senses differing in number and in kind from those that we possess. But all the wonderful phenomena attendant upon insect oviposition by selection, may readily be explained under the supposition that it is guided and controlled by the sense of smell. We know the value of this important sense to us, how greatly it may minister to our pleasure and what service it may render in guarding us from deleterious exhalations and from improper food. It is capable of cultivation to the extent of rendering us still greater service. I have been told of a chemist in one of our colleges, who can make quite a correct qualitative analysis of a patent nostrum, by applying it to his nostrils, and picking out one after another of the ingredients, first naming those which are simply added as covers. It is related of a blind person, that he acquired the faculty of recognizing his acquaintances by the sense of smell. There are negroes in Africa who will follow their masters by scent. A fish-dealer in Albany claims the ability of naming each species of fish offered in the market, when presented to him blindfolded, by the odor peculiar to each. The illustrations given us of the acuteness of this sense in some of our domestic animals, are so numerous as not to need citation. We will quote a single instance of this almost miraculous acuteness, related upon undoubted authority. "A person, to make trial whether a young blood-hound was well-trained, caused one of his servants to walk to a town four miles distant, and then to a market-town three miles further. The dog, without having seen the man he was to pursue, followed him by the scent to the above-mentioned places, notwithstanding the multitude of market-people that went along the same way and of travelers that had occasion to cross it; and when the blood-hound came to the chief market-town, he passed through the streets without taking notice of any of the people there, and left not till he had gone to the house where the man he sought rested himself, and found him in an upper room, to the wonder of those that followed him."

That insects are controlled in the discharge of their most important functions by this same sense, may seem a bold supposition, in view of the fact that, notwithstanding the laborious investigations in insect

structure, conducted through a century by some of our most distinguished scientists, we are utterly unable to point out with positive certainty the precise location and nature of the organs of smell. Naturalists have differed and still differ in their views in regard to their location. Cuvier, Audouin, Dumeril, and Burmeister, have regarded the spiracles, or breathing-pores, as discharging this office. Reaumur, Lyonnet, Latreille, and others, have referred it to the antennæ. Others have believed that the palpi were the true smelling organs, and others that the sense belonged to certain cavities in the front part of the head, and to the mucous lining of the mouth; while Kirby and Spence have thought that they have discovered a nose in the fore-part of the head, which they call the rhinarium or nostril-piece, connected with which is a beautifully-striated structure, which they have described as the veritable organs of smell.*

Although we do not surely know the position and structure of these organs, their existence is beyond a doubt. If a decaying carcass be concealed beneath a sod or other cover, carrion beetles, in their season, may soon be seen hovering over it, seeking it as a nidus for their eggs. I have seen swarms of flesh-flies, *Calliphora vomitoria* and *Lucilia Cæsar*, drawn to the disgusting odor of the "stinkhorn" fungus, *Phallus impudicus*, which so perfectly counterfeits that of decaying flesh.

Collectors of Nocturnal Lepidoptera know the readiness with which

*I am indebted to Dr. Hagen, of Cambridge, Mass., for the following information as to the location of these organs, drawn from *Hauser: Zeitschrift, f. Wissenschaft, Zoologie*, 1880, and giving the latest observations of the best investigators.—

Strong smelling substance, as turpentine, carbolic acid and decayed meats, proved that the organs of smell were situated in the antennæ in very many insects. Nevertheless, not all the insects employed in the experiments were deprived of the sense after the amputation of the antennæ, among which were *Carabus*, *Pyrrhocoris*, etc. After the antennæ were cut, the males rarely mated.

Sensitive bristles are present in Orthoptera (*Œdipoda* and *Caloptenus*) on every joint of the antennæ after the eighth or ninth, and fifty sensitive pits or furrows, which are probably closed by a fine membrane and have interiorly one smelling-rod. *Stenobothrus* and *Gryllotalpa* are similarly provided. Diptera have in the third joint from 100 to 200 furrows, with as many as 200 sensitive bristles. *Vanessa* has on each joint of the knob of the antennæ, fifty furrows. Of the Coleoptera, the Carabids, Cerambycids and Curculionides, possess no antennal furrows, while they are present in the Silphides, Staphylinides and Tenebrionides. The Lamellicornes have on the underside an immense number of very small furrows, viz.: in the female 17,500, and in the male 39,000.

All insects which have to rely upon the sense of smell for discovering their food or placing their eggs, possess many sensitive furrows or pits in the antennæ, as bees, wasps, ichneumons, Diptera and Lepidoptera.

Dr. Hagen suggests that probably in many insects the organs of smell and taste are united. Such may be the organs which are found in the honey-bee in the epipharynx (on underside of the labrum), consisting of numerous sensorial furrows or channels and connected interior structure, and which have just been discovered in the same position in *Pemphigus* and *Cicada*, by Prof. H. Osborn, of the Iowa State Agricultural College (See *Canadian Entomologist*, xiv, 1882, p. 64).

the *Noctuidæ* are drawn to their bait of molasses and beer, spread upon tree-trunks to allure them for capture.

It is to the existence of these organs that some of the families of the Lepidoptera, especially among the moths, owe the continuance of the species. They operate in the association of the sexes, with such an irresistible and far-reaching force as to exceed our conception and to be marvelous to our eyes. The following are a few examples illustrating the exercise of this sense: —

A female moth just emerged from its pupa, within a closed room, has disclosed its presence to its mate and drawn its visit through the only means of entrance — a chimney opening into the apartment. An instance is recorded in which a moth forced its way into a collector's pocket, where, through this same sense, the information had been communicated to it of the presence of a mate, although hidden within a collecting box.

An interesting account has recently been given by Mr. W. H. Edwards of the attraction of *Heliconia Charitonia* (Linn.)* — a butterfly common in Southern Florida, Mexico and Central America — to the female chrysalides of the same species. Two or three days before the inclosed insect bursts her shell and appears in her winged form, the males are attracted to the chrysalis hanging from the passion-vine. Sometimes as many as six males may be seen clinging to a single chrysalis, entirely concealing it from sight. They remain upon it day and night, or if leaving it at all, it is only to feed for a brief interval and return. Lighted matches held under them will not drive them away, nor even shaking the twig. If pulled off by force, after a few circuits in the air, they resume their position. The explanation of this powerful attraction and persistent waiting and watching, admits of no doubt. A chrysalis which had turned almost black, and was momentarily expected to disclose its imago, was seen by the observer to burst at the abdominal end, when, "instantly one of the males made connection with the female imago while the head and thorax of the latter were still enclosed in the shell."

Not long ago, two female Promethea moths — the species whose cocoons are often to be found suspended to lilac bushes during the winter months — had emerged from cocoons in my office and were within a box near an open window. A visitor of the same species soon entered the room through the window, followed by a second, a third, a fourth, while others fluttered against the upper sash endeavoring to effect an entrance. Looking outside, I saw numbers of the males, readily recognized by their dark color and vigorous flight, circling

Papilio, i, 1881, pp. 209–215.

about in front of the window. One after another of the passers-by were arrested by the unusual spectacle of perhaps fifty of the large Promethea moths, congregated in a small space and actuated, apparently, by one common purpose. A crowd of persons, men, women and children, had soon assembled before my window, completely blocking up the sidewalk, and eagerly asking, "what are they?" "where did they all come from?" and, "what are they here for?" I left the window with the questions unanswered, for I did not care to give the information that they were Messrs. Promethea, drawn some of them from the remotest portions of the city, to pay their *devoirs* to the Misses Promethea, within my office. I trust that my reference to these sensorial flights may not be deemed indelicate, for the amorous flutterings of insect wings are but in obedience to a law of their nature, which lies entirely outside of our code of morals, and is of equal, if not superior authority.*

Another confirmation that insects have the perception and appreciation of odors is found in a recent discovery of scent-producing organs in the males of certain Lepidoptera, particularly among the moths. These organs are pencils of hairs, associated with special structure, located in different portions of insects, which emit, at certain times, peculiar odors, resulting from some volatile oils, as is believed. In some of the *Sphingida*, according to Mr. A. H. Swinton,† they are located at the base of the abdomen. In some of the genera of the *Noctuida*, as in *Acronycta*, *Leucania*, *Mamestra*, and *Phlogophora*, they are hidden beneath the first five dorsal arcs of the abdominal segments. In other *Noctuida*, as in *Apamea*, they are at the anus, while in *Catocala* they are to be found in the legs — at the upper part of the second pair of tibiæ. In the *Geometrida*, they are on the posterior

*See, also, in this connection, an interesting account given by Professor F. H. Snow, in the *Transactions of the Kansas Academy of Science* for 1874 [vol. iii], pp. 27, 28, of his observation upon Penikese Island, of the male of *Polyphylla variolosa* (a beetle closely allied to the common May-bug, *Lachnosterna fusca*) digging in the barren soil of the island for the female, when about to emerge from its pupation, while still buried beneath the surface. He states: "My attention was first arrested by a male vigorously scratching the ground with his feet while his antennæ were fully extended with their antennal plates widely separated. His progress being too slow to suit my purpose, I assisted him in his excavation, and at the depth of half an inch discovered a female, who, with head upward, was struggling to reach the surface, having evidently but just emerged from the pupa. A little further on another male was busily scratching the soil, and another female was unearthed directly underneath; while a moment later two rival males were discovered digging for a third female, who was buried nearly an inch below the surface." There can scarcely be a doubt but that the knowledge of the subterranean presence of the females was conveyed, not by the sense of hearing, as was supposed by Professor Snow, but through the antennal organs of smell with which the *male* of the Lamellicornes is so abundantly provided (see *ante*, page 69, in foot-note).

†*Proceed. Lond. Entomolog. Soc.* for 1878, p. 20.

tibiæ in *Boarmia*, *Tephrosia*, and *Acidalia*, and on the submedian vein of the forewing in some species of *Macaria* and *Cidaria*.

The particular effect produced by these odoriferous organs, is not known, but from their being brought in action and extended like a fan, during the union of the sexes, they doubtless serve an important purpose in the economy of nature, by aiding in the continuance of the species. It is not unlikely that attractive odors may be given to the males as a compensation for the more brilliant coloring or more complicated ornamentation often possessed by the other sex.

Special odors pertaining to male butterflies, have been noticed by several entomologists. Dr. Müller has called the attention of the London Entomological Society to the odors of the males of several species of Brazilian butterflies, which he regards as an especial sexual attraction. Miss Murtfeldt has recorded a delicate violet like odor in fresh males of *Callidryas Eubule* (not discoverable in the females), which was retained for several days after death.*

If, as we believe, insects have been given this acute sense of smell, we may see in it a provision admirably adapted to their need. Very many of the insects are night-fliers, sleeping or hiding in concealment during the day, and only coming abroad during the night to deposit their eggs and to partake of a limited supply of food — the latter quite a secondary consideration in their economy. We have no reason to believe, from a study of their eyes, that vision in insects is very acute, and even if it were, it would operate under serious disadvantage under cover of the night. In utter darkness the organs of smell could discharge their functions to their extreme extent — better enabled, perhaps, to do so through the humid atmosphere of night, and stimulated to their full exercise by the more numerous and stronger odors which are emitted from the vegetable world during the hours of darkness.

And again, many insects must find their mates only through searching them out under the seeming disadvantages environing the females of limited locomotion, and a greater or less degree of concealment. As a rule, the females fly less than the males. In some species, as in *Samia Cecropia*, *Callosamia Promethea*, *Hyperchiria Io*, and others, the burden of eggs borne by them render them almost incapable of flight, until the main purpose of their being has been discharged. The females of *Orgyia leucostigma*, *Anisopteryx pometaria*, *A vernata*, *Hybernia tiliaria* and a number of others, are wingless, and therefore incapable of flight. In a moth quite destructive to arbor-vitæ and many other food-plants, *Thyridopteryx ephemeraformis*, or the basket-worm, the

*Psyche, iii, 1881, p. 198.

necessity of eyes is not apparent, for the sexes never can see one another. Not only is the greater part of the caterpillar life of the female passed within its bag or basket, but inside of its walls it attains its growth, it undergoes its pupation, it changes to the mature insect, the eggs are fertilized, and the mother dies. It never emerges from its cocoon. Sight alone *could not* have brought about the fertilization of the eggs, nor could other sense than the one with which we believe insects to be, for necessary uses, specially endowed.

When we recall larval growth, and the source from which the larva derives the material which forms its entire structure, it will seem but natural, that when, through transformation, it has attained its perfect state, it should be peculiarly sensitive to the presence of its food-plant and be led to select it for oviposition, through the exercise of its most acute sense. Take, for illustration, the familiar caterpillar of the tomato plant, known as *Sphinx quinquemaculata*. In its larval state it lives but to eat and grow. Its skeleton — its outer integument — can not grow fast enough to meet its insatiate demand for food, and therefore, at intervals — four several times — it is cast off and a new and more capacious one is supplied. Observe the play of its powerful jaws: unless frightened into temporary quiet, they almost give us a perpetual motion; they rest not day or night; their sweep is like a mower's scythe, and a tomato leaf disappears before them as a meadow falls before a mowing machine. The creature is scarcely more than an animated eating apparatus. Its life is passed on a single plant, if that suffices for its appetite. It never tastes other food. And when it has finally attained its beautiful winged form, every particle entering into its composition, of fluid, nerve, muscle, and chitin, is but transmuted tomato leaf. Is it strange, then, that the moth should be able to know tomato when it smells it? Would it not be more strange if its organs of smell should respond to any other odor? This alone would be familiar to it — others, perhaps, might be acquired.

Having now offered plausible reasons, why, from physiological causes, insects may be supposed to be extremely sensitive to the odor of their natural food-plant, — having shown the important purposes that the possession of this sense in an acute form may serve them in the perpetuation of the species — and having presented some marvelous manifestations of insect attraction, sexual and otherwise, which are only explicable upon the theory that they are directed by the sense of smell, — need we hesitate to accept the opinion advanced, that many of our more injurious insects are guided in the deposit of their eggs by the sense of smell alone.

There are classes of insects in which oviposition would not be con-

trolled by this sense, for example, most of those which in their larval stage live in the water and are predaceous upon other animal life, as many of the Neuroptera and some of the Coleoptera. The purpose of oviposition in such is accomplished if the eggs are deposited convenient to water. Then there are Hymenoptera, as bees and wasps, which place their eggs in cells constructed by them, having previously provided for the grubs to be hatched, their needed food; and Orthoptera, that only require for their eggs secure deposit in the ground. Exceptions to the rule need not be multiplied, for they will readily present themselves.

And now, to proceed without further delay to the application which it is proposed to make of the views above presented, of the particular sense, which, in many insects, controls their oviposition. If the insect discovers the plant upon which its larvæ feed, and is drawn to it for the deposit of its eggs by the peculiar odor characterizing and emanating from it, then, if that odor be neutralized or overpowered by the introduction of another stronger odor — a counterodorant, it might be termed — eggs will not be deposited upon the plant: it will be preserved from such attack as effectually as if it were inclosed in glass.

We already know several substances, some of which have been named, which are sufficiently powerful to overcome many vegetable odors. It is not necessary that they should be disagreeable or repulsive to the insect. We need not, therefore, search for substances disagreeable to us, which might prove quite otherwise to insects. We do not know that camphor, carbolic acid, or naphthaline, when inclosed in our insect cabinets, preserves them from the entrance of the *Anthrenus* and *Dermestes*, by being disagreeable or repellant to them, but we do know that their strong odor is sufficient to overpower that of the dried insects, so that the pests may not be attracted for the deposit of their eggs. We have doubtless erred in assuming that certain odors are disagreeable to insects, and that for this reason their presence protects from insect attack. That some odors are not *attractive* to them is probably true, and in this truth may lie the explanation why certain individuals enjoy immunity from the attack of mosquitoes, bed-bugs and fleas in infested localities. The protection afforded to visitors of our northern wilderness from the black-fly and the mosquito, through pennyroyal, oil of tar, and carbolic ointments, results, doubtless, from their overpowering the odor proceeding from the exposed portions of the body; and, in the same way, the creosotic odor of the smudge-fire smoke prevents the attack of the midge.

The chief requisites in the materials to be employed for plant protection, in the manner proposed, are strength and permanency; the lat-

ter quality contributing to economy of material and labor of application. A degree of strength not wholly overpowering would be proportionately protective in lessening the distance at which the plants would attract. If the above properties were embodied in a fertilizer, the resultant benefit would be enhanced by enabling the plant better to resist, through vigorous growth, any form of insect attack. Among manures, the drainage from pig-styes has been found to act with great efficiency in preventing the egg-deposit of the Anthomyia flies upon onions, radishes, turnips and similar crops. The dry manure from piggeries has a remarkably pungent and strong odor, when distributed upon lands, and we can all recall the offensive, almost insupportable, odor escaping from a passing freight-train laden with swine, from some remote point in the West. It is very probable that upon our seaboard, where the mossbunker (*Brevoortia menhaden*) and other fish can be obtained in quantities to permit of their use as manure, they will prove of great value in protecting from egg-deposit. The gas-works of our cities and the farther distillation of coal-tar, in the various uses to which it is applied, should afford us several valuable materials for this purpose.

Can not chemistry come to the aid of the economic entomologist, in furnishing at a moderate cost the odorous substances needed? Is the imitation of some of the more powerful animal secretions impracticable? It *has* been thought possible, and a distinguished perfumer has long been experimenting at a cost of thousands of dollars, in the production of a substance having the properties of the peculiar secretion of the *Mephitis mephitica** (the skunk), to serve as the basis of a perfume which would, he is confident, enrich the discoverer. Can there be any doubt of the conservative action and the value of this substance as a counterodorant, could it be obtained in sufficient quantity; and what an additional charm would its general employment impart to horticultural and agricultural pursuits, when the alembic of the chemist shall have converted it into a delightful perfume, as proposed, surpassing in agreeability even that of musk—a similar animal secretion.

What would be the result, it may be asked, should this method of plant protection from insect oviposition prove effectual and be generally adopted? Might it not produce serious disturbance in the

*If, in our zoological nomenclature, we were permitted to go beyond the names given in the tenth or twelfth edition of Linné's *Systema Naturæ*, in 1758 and 1766, this animal, in strict compliance with the law of priority, might now be known by the name under which it was originally described in 1744, by the French Naturalist, Charlevoix, viz.: l'Enfant du Diable—*the devil's own child*. Certainly the designation would be quite as expressive as the scientific one which it now bears.

economy of nature, of the relations existing between the insect and the vegetable world?

A friend — a distinguished jurist and an accomplished botanist — whose opinion had been asked upon this new method of protection from insect attack, with that judicial habit of thought which leads him to meet a new proposition first with the question, "is it right," and afterward, "is it useful," gave me the following note in reply, presenting, although under a vein of pleasantry, some of the objections that arose in his mind. He asks: "Ought I to countenance recommendations which may prove disastrous to the great scheme of nature? Scatter that mischievous carbolic acid all over or around the plant nature has commanded the insect to lay her eggs on, and the leaves of which she has given to the children of those eggs for food, and what tremendous consequences may ensue! She must and will lay them somewhere, and if, being unable to distinguish the plant devoted to her use by nature, she lays them on another species — if, for instance, the eggs designed by nature for a mint, be laid upon an oak, a mullein or the tomato, what monsters may not the grubs be evoluted into? Varieties of silk-worms have been evolved from differences of food. The progeny may differ very widely from their progenitors, be far more destructive, and ruin much more precious plants."

"This awful protection may not only be productive of new insect enemies, but it actually aims at striking out of the chain of life one animated link. The insect, led by the nose to the plant to lay its eggs on, fails to lay them. Another insect, which feeds upon the eggs or larvæ, is led by its nose to the plant, but fails to find its food and dies of inanition; its parasites perish with it; — and thus, link after link is broken, and the frame of nature is disordered and falls into disconnected fragments, and all life is obliterated and vanishes *in fumo* — the foul, all-pervading stench of carbolic acid. I'll none of it!"

The above picture of the full realization of the purposes of the practical entomologist, although drawn in the colors of badinage, calls for a serious reply, as it is one not unfrequently held up to view by those who regard our efforts as chimerical. We do not propose to exterminate — but only to control. The true naturalist would not, had he the power, strike out of existence a single species of insect, believing, as he does, that each one has its place and purpose in nature. There is ample food for every species — possibly, under ordinary circumstances, for all individuals, although doubtless certain species might be diminished in number without violence to the harmony of nature. For this excessive multiplication of individuals, the agriculturist and the horticulturist are at fault, in inciting and encouraging insects to such multiplication by offering them food greatly superior to, and far more

tempting under their cultivation than their original wild food, and massing it in gardens, orchards, and fields, where the united odors of many acres extend irresistible attraction. Since, therefore, they have unduly multiplied injurious insects, it is their undoubted right and their bounden duty, to diminish their number, if by so doing, while advancing their own interests, they also promote the public good.

The method of protection herein suggested would be attended with the following direct results. Let us illustrate by its operations upon a single food-plant: If, by means of smoke, or other counterodorant, an apple orchard be protected from egg-deposit, the odor-attracted apple insects, failing to recognize it, will wing their way to other orchards. These in turn must be protected. As the area protected increases, the number of eggs deposited in unprotected orchards increases proportionately, compelling a resort to preventive means, if remunerative crops are to be grown. When at length not a single well-cared-for orchard offers its odorous invitation, the neglected, worthless ones, of which there are far too many within our State, standing only as nurseries of insect pests, are seized upon and, fortunately, soon destroyed. Single trees, scattered here and there, must now be resorted to. The aggregate of food supply has been greatly reduced, and only a diminished number of insects can be fed. In the lengthened insect flight in search of food-plants, insectivorous birds find more abundant prey. The steadily diminishing number of insects are driven back step by step to their native food-plant — the wild crab — upon which they subsisted for long ages before apple orchards of hundreds of acres of delicious fruit were known. The crab, the wild cherry, the wild plum, the thorns, with some other members of the family of *Rosaceæ*, will furnish all the food that our one hundred and fifty apple insects require for their support. Here they may feed, unmolested by the economic entomologist, except as he may chance to need an occasional specimen for study or with which to enrich his cabinet.

Let the apple-tree stand for every other plant that we value, and for which we seek protection, and let the attacking insects of each, in the manner above suggested, be driven from them to their corresponding wild plants; then shall we have accomplished all that our economic investigations may aspire to. Its complete realization we shall never attain, either by the method now proposed, or through any other; but in proportion as we approach it, in the same degree will the earth yield her increase more abundantly in willing return to the labors of the husbandman.

CLASSIFICATION.

It was intended to present with this Report a general view of the Classification of Insects, to the extent at least, of giving the more prominent characters of the several orders and of the principal families into which insects are divided, but the length to which the introductory remarks of the preceding pages has extended, compels the postponement of the purpose to another year. A certain amount of elementary knowledge — such as shall embrace the essential features of the principal divisions of insects, a recognition of the several forms under which they present themselves during their transformations, and familiarity with some of the names applied to portions of insect structure, is indispensable to every one who would intelligently observe insects and who desires to avail himself of the information which is so freely and abundantly offered in the economic entomological literature of the day. As such knowledge is supplied in but few of our public schools, or even higher institutions of learning, the entomologist, in his communications with the public, is compelled to presume upon a surprising and, as it appears to him, a criminal lack of even an elementary acquaintance with the insect world.

As the insects to be discussed in the following pages will each, after its scientific and popular name, be referred to its order and family, it seems but proper that they should be preceded by a mention of the several orders, their meaning, and the common names of some of the insects which they embrace.

While authors differ in their systems of classification, the one most generally adopted in this country recognizes the division of six-footed insects or *Hexapoda* (the spiders, or *Arachnida*, and the centipedes, or *Myriopoda*, forming the other divisions of the Class of Insects) into seven orders, which, commencing with those deemed highest in rank, are the following :—

1. Hymenoptera — (of Greek derivation, from *hymen*, a membrane and *ptera*, wings) comprising bees, wasps, hornets, ants, ichneumon flies, saw-flies, etc.

2. Lepidoptera — (from *lepis*, a scale, and *ptera*, wings) embracing butterflies and moths — the former diurnal and the latter usually nocturnal.

3. Diptera — (from *dis*, twice, and *ptera*, wings) comprising flies, mosquitoes, gnats, sheep-ticks and some other wingless forms, etc.

4. Coleoptera — (from *coleos*, a sheath, and *ptera*, wings) including the beetles, as the carpet-bug, May-bug, rose-bug, snapping-bugs, lightning-bugs, weevils and lady-bugs.

5. Hemiptera—(from *hemi*, half, and *ptera*, wings) including plant-

lice, scale insects, mealy bugs, tree-hoppers, lantern-flies, seventeen year locusts, the bed-bug, body-lice, etc.

6. ORTHOPTERA —(from *orthos*, straight, and *ptera*, wings) including crickets, locusts (the true), grasshoppers, walking-sticks, cockroaches, Croton-bugs, etc.

7. NEUROPTERA — (from *neuron*, nerve, and *ptera*, wings) including white-ants, May-flies, dragon-flies, lace-wings, ant-lions, caddis-worms, etc.

Several other orders have been proposed, and have been adopted, in whole or in part, by entomologists, as they differ in their views as to the extent to which these divisions should be carried. Some of them contain but a single family each, or a Linnean genus. As of interest to the student, and as explanatory of differences in classification which may present themselves to the general reader, they are here given :—

APHANIPTERA, of Kirby (inconspicuous wings), or APTERA Leach (wingless): consisting of the flea family (*Pulicida*) above included in Diptera.

STREPSIPTERA, of Kirby (twisted wings); the RHIPIPTERA, of Latreille: consisting of bee parasites, constituting the family of *Stylopidæ* of Coleoptera.

HOMOPTERA, of Latreille (equal wings): embracing those of the Hemiptera which have the wings wholly membraneous, the remainder being placed in a separate order of HETEROPTERA, of Westwood (dissimilar wings).

EUPLEXOPTERA, of Westwood (well-folded wings), or DERMAPTERA, of Leach (skin-wings): consisting of the family of earwigs or *Forficulidæ*, usually placed in Orthoptera.

THYSANOPTERA, of Haliday (fringe wings): containing the minute insects known as Thrips, of the family *Thripidæ*: generally classed with Homoptera, although having affinities with both Orthoptera and Neuroptera.

TRICHOPTERA, of Kirby (hairy wings); containing the caddis-flies, or *Phryganidæ* of the Neuroptera.

HOMALOPTERA, of Leach; containing the spider-flies, bird-flies and sheep-ticks of the families of *Hippoboscidæ* and *Nycteribiidæ* of the Diptera.

THYSANURA, of Latreille — (from *thysanos*, a fringe, and *oura*, a tail): containing the bristle-tails or *Lepismatidæ* and the spring-tails, or *Poduridæ*, usually united with the Neuroptera.*

*Dr. Packard, in his last edition of his *Guide to the Study of Insects* (1878), accepts this Group as an 8th Order, to be added to the seven usually adopted.

MALLOPHAGA — (from *mallos*, wool, and *phago*, to eat); containing the bird-lice of the Hemipterous group *Mallophaga*, having jaws for feeding on the delicate parts of the feathers and hairs of birds and mammals.

BIBLIOGRAPHY.

A feature introduced for the first time in our State Entomological Reports, and which it is hoped will meet with approbation, is the list of references to publications which will precede each species discussed, giving in addition the synonomy when the species has been known under different names. It is not attempted to make the lists as full as those presented in the popular volumes of Dr. Coues on *The Birds of the North-west* and *The Birds of Colorado Valley*, and by other recent writers in Natural History, for such elaborate and valuable compilations can only be the fruit of the systemized study of years with this purpose in view, together with unusual facilities for the work. It is only proposed to cite the author of the species and its first publication; to give a few references to European authors when such occur and seem to be of value to the entomological student; to note some of the best figures which have been given; and to refer to such of the notices occurring in the recent entomological literature as have come under observation, many of which may be accessible to the general reader, in the Reports of our State Entomologists, Agricultural Reports, and leading agricultural journals.

A bibliography limited to this extent should not be regarded as objectionable by those who have no desire to avail themselves of it; while the student who would gladly obtain more extended information of the species than that presented, may find it of practical value. Full bibliography, in all departments of Natural History, is of great importance in scientific research, and it is much to be regretted that the vast amount of labor which it involves so seldom permits it to be presented. If shared by many, each contributing his mite, the task will be materially lightened and eventually accomplished.

Thyridopteryx ephemeræformis Haworth.

The Bag or Basket-worm.

(Ord. LEPIDOPTERA : Fam. BOMBYCIDÆ.)

Sphinx ephemeraformis. HAWORTH: Lepidoptera Britannica, 1810, p. 72.

Ægeria ephemeraformis. STEPHENS: Illus. Brit. Entomol., Haust., i, 1828, p. 145.

Thyridopteryx ephemeraformis. STEPHENS: Illus. British Entomol., Haust., iv, 1835, p. 387; in Trans. Ent. Soc. Lond., i, 1836, p. 76, pl. 10, f. 1.

Oiketicus sp. MELSHEIMER (1840): in Harr. Corr., 1869 p. 113.

Oiketicus sp. HARRIS: Treat. Ins. New Eng., 1852, p. 319; Ins. Inj. Veg., 1862, p. 415; Ent. Corr., 1869, pp. 150, 243, 246; Ib., *Oiketicus coniferarum*, pp. 177, 299, pl. 3, f. 4.

Thyridopteryx ephemeraformis. MORRIS: Synop. Lep. N. Amer., 1862, p. 142.

Thyridopteryx ephemeraformis. PACKARD: in Proc. Ent. Soc. Phila., iii, 1864, p. 350; Ib., *Œceticus coniferarum* Harris MSS., p. 351; Guide Stud. Ins., 1869, p. 291, f. 222; Ins. Inj. Forest and Shade Trees, 1881, p. 248.

Hymenopsyche coniferarum. GROTE: in Proc. Ent. Soc. Phila., v, 1865, p. 249; *Thyridopteryx ephemeræformis*, New Check-list Amer. Moths, 1882, p. 18, no. 202.

Thyridopteryx ephemeraformis. CLEMENS: in Proc. Ent. Soc., Phila., vi, 1866, pp. 221, 222; in Tineina N. Amer. (STAINTON), 1872, p. 274.

Thyridopteryx ephemeraformis. GLOVER: in Month. Repts. Dept. Agricul., 1863, p. 423. — RATHVON: in Prac. Entomol., ii, 1857, p. 53. — RILEY: First Ann. Rept. Ins. Mo., 1869, pp. 147–151, f. 84. — KING: in Psyche, iii, 1871, p. 241. — LINTNER: in Count. Gent., xlv, 1880, pp. 535, 631. — MARTEN: in Thomas' Tenth Rept. Ins. Ill., 1881, p. 118, f. 32. — H. EDWARDS: in Papilio, ii, p. 24.

Numerous reports reached me from the southern portions of the State of New York during the summer of 1880, of depredations upon arbor vitæ, which I was able to refer to the above-named insect. A letter from West Brighton, Staten Island, stated: "I have recently found several arbor vitæs standing together in a row completely stripped of their foliage, and covered with cocoons like those sent, strongly attached to the twigs. I have never before remarked any thing of the kind. Please inform me whether you know of the arbor vitæ being frequently despoiled in this manner. If so, its usefulness as a hedge plant will be greatly impaired."

The Bag or Larval Case and the Insect.

The case built by this insect for its shelter during its caterpillar stage, and subsequently to serve for its cocoon within which to undergo its pupation, is so peculiar in appearance and structure, that

once seen, or even after a study of its description and illustration, it cannot fail of being recognized. There are other species of basket-worms occurring elsewhere which construct similar cases. They are very much alike, except in size, usually of an elongate, pointed, oval form, and are composed of a tough silk, interwoven with bits of the leaves and pieces of the stems of the food-plant upon which they are found.

These cases are always worn by the larvæ, and when, toward maturity, they have, by continued additions, increased to a large size, they hang downward (whence their name of *bag-worm*), in apparently a cumbersome burden, but, firmly held by the abdominal segments and their legs, they are carried about with the greatest ease, by means of the anterior segments and their three pairs of legs extended from the case, as shown in Fig. 13 at *f*. When alarmed, the larva retreats within its case, where it is kept from falling by the silken thread which it spins and attaches to the twig in its travels over the tree. To those who are unfamiliar with the strange-looking cased caterpillars, they and their operations and movements are of great interest. They commence their cases as soon as they escape from the eggs. These at first appear as little tips of extraneous matter attached to and surrounding their hinder end. Gradually they assume the form of a cone, beneath which, when drawn down to the surface of the leaf, the caterpillar is entirely hidden, as represented in the little cones at *g*. With the larval growth the cones are enlarged, until they become the oval cases which cover all but the anterior portion of the larva while feeding.

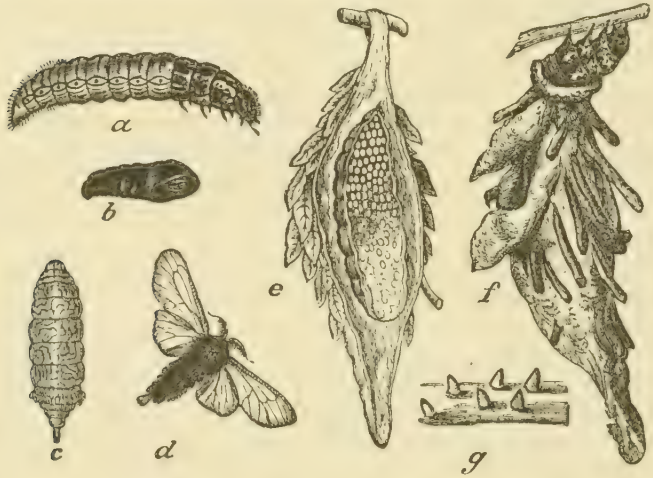

FIG. 13.—The Bag-worm, THYRIDOPTERYX EPHEMERÆFORMIS.—*a*, the caterpillar; *b*, male pupa; *c*, wingless female moth; *d*, male moth; *e*, section of female pupa and cocoon; *f*, case or bag of mature caterpillar; *g*, cases of young caterpillars.

The male moth, shown at *d*, is of small size (an inch in spread), and very plain in appearance, with its transparent and thin wings. The female is very imperfectly developed, as may be seen from its figure at *c*. It has neither legs, wings, antennæ, or any external features from which one would be led to refer it to the order of Lepidoptera. It is scarcely more than an animated, although a very sluggish, egg-case.

The immense number of eggs which it contains and their arrangement, is shown in a section of its pupa within its cocoon-case at *e*. It is never seen unless the case is opened, for within its inclosure, its entire life in its moth state is passed. Indeed, the case shelters it during nearly all of its larval stage, throughout its pupation, its transformation to the moth, its copulation with the male, its oviposition, and its death.

Those who may desire to acquaint themselves more fully with the many interesting details that enter into the life-history of this species are referred to the excellent paper upon it, by Professor Riley, contained in his *First Report on the Insects of Missouri*.

Difficulties attending the Classification of the Species.

The singular appearance of this insect, so unlike most of the Lepidoptera, was the occasion of much perplexity in its classification for a number of years after its discovery. As may be seen from its synonymy, it was originally described as a *Sphinx*, although possessing none of the characteristic features of the *Sphingidæ*. Previous to this, it had been believed to be a species of *Tinea*. Later it was regarded as belonging to the *Ægeridæ*. An interesting paper upon the species, assigning it to its true position among the *Bombycidæ*, was communicated by Mr. J. F. Stephens to the *Trans. Ent. Soc. Lond.*, i, 1836, p. 76, under the title of "On the Apparent Identity of Sphinx ephemeræformis of Haworth with Psyche plumifera of Ochsenheimer," of which the following is the substance.

It appears that the original specimen was found in Yorkshire by Mr. Boton, and was placed in Mr. Drury's collection. At the sale of this collection, it was purchased by Mr. Donovan, and at an auction sale of some of Mr. Donovan's insects, in the catalogue of which it was announced as "an undescribed *Cossus ligniperda*," it came into Mr. Stephens' possession. Mr. Stephens was able to see, upon a cursory inspection, notwithstanding its mutilated condition, that it was not a *Sphinx* or even one of the *Sphingidæ*. He referred it to "the singular group known by the name of Sackträger by the Germans, and considered by some writers as belonging to another order of insects — *Trichoptera* Newman, *Phrygania* Scopoli, and *Tenthredo* by Roda; in fact it appears to be a *Psyche* of Ochsenheimer [*Psyche plumifera*], so far as can be ascertained by the remains of the unique specimen." Reasons are given why it could not be classed among the *Ægeridæ* where it had been placed in the first volume of *Illustrations of British Insects*, 1834, "nor had it any alliance with *Zeuzera*, to which genus it would appear Donovan had assigned it." It did not fully agree with *Psyche*, and a new genus — *Thyridopteryx*, was constituted for it.

The above genus had been published by Stephens prior to the above paper, in vol. iv, of his Illustrations, page 387, printed in 1835.

The following generic diagnosis accompanied it:

Antennæ short, deeply pectinated on both sides at the base and apparently simple at the base; *head* small, *eyes* globose, rather prominent; *thorax* very robust; *abdomen* also robust at base and gradually attenuated to the apex; *wings* completely hyaline; anterior elongate-lanceolate, discoidal areolet closed, and with a central longitudinal nervure; first and fourth marginal nervures furcate; posterior wings small.

It was believed to be allied to *Psyche* and *Fumea* and was assigned place immediately preceding these genera.

Food-Plants of the Larva.

The caterpillar is a very general feeder, readily feeding on a large number of our fruit, forest, and other trees. It has been observed on apple, pear, plum, cherry, choke-cherry, apricot, quince, linden, maple, locust, oak, elm, poplar, osage orange, spruce, hemlock, larch, red cedar, and arbor vitæ. For the last two, it seems to manifest a decided preference. The accounts of its ravages during the year 1880, which appeared in agricultural journals, were unusually numerous, and in the majority of instances, the arbor vitæ was the greatest sufferer.

Geographical Distribution.

The species is a southern form, and does not occur extensively in the State of New York. It has not been found in the vicinity of Albany, and I know only of its occurrence within the State, on Long Island and Staten Island. Its presence, and injuries from it, are recorded in Pennsylvania, Maryland, District of Columbia, Virginia, Carolina (North and South), Georgia, Alabama, Kentucky, Ohio, Illinois, and Missouri.

Natural Enemies.

Notwithstanding the concealed life of this caterpillar, it appears to be quite liable to parasitic attack, for no less than six parasites are known to destroy it. They are the following:

Pimpla inquisitor (Say).— Mr. Glover mentions the destruction of *Th. ephemeræformis* by *Cryptus inquisitor*, a small, yellow-banded ichneumon fly, with no other information in regard to it.* Originally described by Say in the genus *Ichneumon*,† it was afterward referred to *Cryptus*, and in 1870 it was placed, by Mr. Cresson, in *Pimpla*, in a synoptical table given of the known species of that genus.‡ The dis-

**Rept. Commis. Agricul.* for 1866, p. 41; for description of the larva and pupa, see *Bulletin No. 3 of the U. S. Entomolog. Commis.*, p. 45.

†*Contributions to Maclurian Lyceum*, i, 1827, p. 71.

‡*Trans. Amer. Entomolog. Soc.*, iii, 1870, p. 144.

tinctive features assigned to it in the table by which to distinguish it from its congeneric forms, are "Body black; legs and coxæ yellowish-red; posterior tibiæ black annulated with white; posterior tarsi white, the joints tipped with black; antennæ unicolorous, brown or ferruginous; *abdominal segments entirely black; areolet of anterior wing complete; head entirely black in female, face white in male; tegulæ white.*" The italicised characters separate it from the next species mentioned.

Pimpla conquisitor (Say).*— This species, not hitherto published, to my knowledge, as a parasite upon the bag-worm,† was obtained from some bags kindly sent to me by Mr. F. G. Shaw, of West Brighton, Staten Island, N. Y. In the package containing about two hundred of the bags, when opened upon its reception, October 12th, four of the Pimplas were found alive. Others continued to emerge until November 8th — not in large numbers, however — twenty-one examples only being obtained. Probably not many had left the cocoons previously, as it seems to be a late species, in the Southern States making its appearance in mid-winter or early spring, and attacking only the *last brood* of cotton-worms. Quite a difference in size was shown in the examples, especially in the female, the largest measuring eight-tenths of an inch to the tip of the ovipositor, and the smallest but four tenths.

A popular description of this species, as a common parasite upon the cotton-worm, was given in 1847 by Dr. B. G. Gorham, of Louisiana, which is quoted in Prof. Comstock's *Report upon Cotton Insects*, 1879, p. 190. On page 198 of the same Report, the insect is figured, accompanied with Say's original description of the two sexes — the female described as a distinct species under the name of *pleurivinctus*.

Hemiteles? thyridopterigis Riley.— This species, belonging with the two preceding species to the *Ichneumonidæ*, was described and figured by Prof. Riley from five examples bred from a cocoon of the basket-worm.‡ It is a small form, being about one-third of an inch in length, and one-half inch or less in expanse of wings. The ovipositor is about one-half the length of the abdomen. The sexes are quite unlike in appearance, for while the female is of a dull ferruginous color, with its front wings covered by two dark bands, the male is shining black with the wings destitute of bands or spots. Other dif-

Bost. Journ. Nat. Hist., i, p. 234.

†It is possible that the example referred to by Say as "obtained from a follicle of the common folliculate Linnean *Bombyx* with transparent wings, extremely abundant a few years since in Maryland," was the *T. ephemeræformis*, although it was identified as *Clisiocampa Americana*, the apple-tree tent-caterpillar, by Mr. Walsh. See statement and footnote on p. 45 of Bulletin No. 3 of the U. S. Entomological Commission.

‡*First Rep. Ins. Mo.*, 1869, p. 150, pl. 2, figs. 11, 12; same description in *Bull. No. 6, U. S. Ent. Comm.*, 1881, p. 65.

ferences are indicated in the description. This species is stated to be quite common in Washington (the described examples were from St. Louis, Mo.), where it is often attacked by a secondary Chalcid parasite.

Two other species of this genus, viz.: *Hemiteles Smithii* and *H. sessilis?* are parasitic upon *Samia Columbia*, and have been taken from its cocoons by Dr. Hagen.*

Chalcis ovata Say.— This large and beautiful Chalcid parasite, and the following minute one, were obtained by me from the Shaw sending of cocoons, and are now for the first published as parasitic upon the species. Two examples of *C. ovata* were given out, the first on October 21st; later, another was found dead underneath the cocoons.

Like *Pimpla conquisitor*, it is also a common parasite upon the cotton-worm in the Southern States. Examples of it continued to emerge from the pupæ of the cotton-worms sent to the Department of Agriculture for breeding, from the 4th of August until the 10th of September. It is figured on page 195 of the Report upon Cotton Insects, and the original description of Say is given. The figure may also be found in the Departmental Report for the year 1879.† Prof. Riley has described its earlier stages (larva and pupa), and recorded its widespread distribution throughout the Southern States, West Indies and Mexico; also his having reared it from *Desmia maculalis*, the grape-leaf folder, in Missouri, and from two species of butterflies, *Apatura Lycaon* (Fabr.) and *A. Herse* (Fabr.) in the Southern States.‡

It is among the larger forms of the genus, measuring one-fifth of an inch in length; but one much larger has recently been described by Mr. Ashmead, from Florida, under the name of *Smicra gigantea*, which is 0.43 of an inch long.§

Pteromalus sp. — This species has not been determined specifically, but it appears to be closely allied to *P. puparum*, the parasite so destructive to the cabbage-butterfly, *Pieris rapæ*, of which large numbers frequently issue from a single chrysalis. The attack of this species seems not to have been a strong one, for only sixteen specimens were obtained. They were taken during the latter part of October and first week of November, either at rest upon, or very slowly moving over, the cases, and it is not, therefore, known, whether they all emerged from a single pupa.

Prof. Riley, to whom I owe the identification of the above Chalcids, informs me that he has also reared them from the *Thyridopteryx*, and, in addition, the dipterous insect mentioned below.

**Bull. Buff. Soc. Nat. Sci.*, ii, 1875, p. 208.

†*Rept. Commis. Agricul.* for 1879, plate 12, fig. 13.

‡*Bull. No. 3, U. S. Ent. Commis. — The Cotton-Worm*, 1880, p. 42.

§*Canadian Entomologist*, xiii, 1881, p. 90.

TACHINA ? sp. — This fly, a large bluish Tachinid, has not been specifically determined. Its eggs had been found by Prof. Riley commonly attached to the bags, always externally near the neck, whence the young larvæ, upon hatching, worked their way into the case. They frequently failed, however, to reach their victim, as was proved by a number of empty egg-shells upon bags in which the larva was not parasitized.

Remedies.

Undoubtedly, either of the arsenical insecticides applied to their food-plants would destroy the young larvæ; but the best method of arresting the depredations of this insect, when it abounds to an annoying extent, is to collect the cases by hand when they have attained a size to permit of their easy discovery, and crush or burn them. This is a very effectual method with this species, for as the female has not the power of flight, being without wings, and never leaves its case even for the deposit of its eggs, a tree which has once been completely de-caterpillared (to translate a French word), can only become re-infested from contact of its branches with another infested tree, or from such a proximity to it that the intermediate space of ground could be traversed by caterpillars driven to migration for their food. The inconvenience of dragging their rough cases over the ground would prevent their travel to any great distance.

An instance is recorded of two barrels of the cases of this insect having been gathered and destroyed at one time from some young trees in a public park in the city of St. Louis, Mo.*

Tolype laricis (Fitch).

The Larch Lappet.

(Ord. LEPIDOPTERA : Fam. BOMBYCIDÆ.)

Planosa laricis FITCH : in Trans. N. Y. St. Agricul. Soc. for 1855, xv, 1856, pp. 494–501, pl. 2, figs. 5,6; 1st and 2d Rept. Ins. N. Y., 1856, pp. 262–269, pl. 2, figs. 5, 6.

Gastropacha laricis. MORRIS : Synop. Lep. North Amer., 1862, p. 234 (description).

Gastropacha vellida (Stoll), var. *minuta* GROTE : in Proc. Ent. Soc. Phila., ii, 1863, p. 433.

Tolype laricis. PACKARD : in Proc. Ent. Soc. Phila., iii, 1864, p. 387; Ins. Inj. Forest and Shade Trees, 1881, p. 254.

Tolype laricis. GROTE : in Proc. Amer. Philosoph. Soc. for Nov. 1874, xiv, p. 262.

Tolype laricis. GILBERT : in Papilio, ii, p. 25 (food-plant and date of collection).

The common name of the larch lappet-moth given to this species by its original describer, Dr. Fitch, was in consideration of the par-

**First Report on the Insects of Missouri*, 1869, p. 151.

ticular food-plant, upon which, up to that time, it had only been observed: it is, however, now known to occur upon the pine and hemlock, and will doubtless be met with upon other of the evergreens. The designation of lappet is borrowed from English writers who have employed it for those caterpillars which are characterized by lappets or leg-like appendages, placed in line on their sides, from which many long hairs are given out, which nearly or entirely conceal the legs by forming a lateral fringe to the flattened body.

Protective Mimicry.

The generic name of *Planosa*, meaning, in the Greek, a deceiver, which Dr. Fitch proposed for this species, referred to the deceptive appearance which it presents in both its caterpillar and moth stages, and which is a prominent characteristic of its associated lappet caterpillars. Dr. Fitch has so ably and so faithfully described this feature, that we transcribe what he has written: —

"The modes by which nature has endowed many insects to enable them to elude the search of birds and other enemies are truly wonderful. Among the insects thus endowed, the lappet-moths and their caterpillars have often excited the admiration of the curious. The latter, when in repose have the body flattened, somewhat like that of a leech, and on each side of each segment projects a little lappet or flat lobe. These lappets are pressed down upon the surface of the limb on which the worm is at rest. The sides of the body are also fringed with hairs which are similarly appressed to the limb. Thus all appearance of an abrupt elevation or an interstice to indicate the ends and sides of the worm is obliterated, and it resembles merely a slight swell of the natural bark, the deception being made complete by the color, which is commonly identical in its hue with the bark. And when there are spots or marks upon the caterpillar, they imitate the glandular dots, scars, and other discolorations which will be seen upon the bark around it. Even upon the closest scrutiny, the eye fails to detect any thing by which we can be assured this elevation is not a tumor which has grown in the bark. * * * * The cocoons which they construct upon the limbs are equally exact counterfeits of the bush. One of these upon a limb of the wild black cherry is now in the museum of the State Agricultural Society. It is placed longitudinally in the slight angle formed exteriorly where one limb branches from another, and a piece of putty could not be more perfectly moulded into this angle and smoothed off so as to leave no inequality. The bark of the cherry is blackish with transverse whitish streaks, and this cocoon presents the same colors and of tints almost

the same, and what is most remarkable, it in one place shows a whitish streak continued from the bark upon the surface of the cocoon. And finally, in their perfect state, the moths imitate appearances which are common upon the particular trees on which they dwell: those upon deciduous trees, in the colors and scalloped margins of their wings resembling a tuft of withered leaves; those upon evergreens resembling a scar where the turpentine has exuded and concreted into a whitish mass."

The above statements are not too highly drawn. On the occasion of my rearing a colony of the caterpillars, noticed below, I called the attention of an entomological friend, who prided himself on the possession of naturally keen sight so trained by long experience in collecting, that few caterpillars could escape his eye, to four of these larvæ upon a small twig before him. They were extended at length upon the side of the twig toward him; they were within reach of his extended finger; but he was unable to discover them until their presence was revealed to him, by my touching them one after the other, and eliciting unmistakable evidence of life. Their cocoons which I have met with abroad, wonderfully borrowed the hue of the bark where they rested, and simulated excrescences upon the twigs. One of them, more conspicuously placed than many, is shown in Fig. 14.

Fig. 14. – Cocoon of Tolype laricis, attached to a twig.

The Species Usually Rare.

The insect is probably not rare in nature, but for the reason above given, it usually eludes observation. The caterpillars remain motionless during the day upon the bark, which they only leave on the approach of night for feeding on the leaves. The flight of the moths is almost confined to the male sex: their colors are dingy and obscure: they take wing after night-fall, and we may venture to assert that their flight extends but little beyond the "bee-line" in which they are unerringly drawn to their mates. The species is a rarity in our collections. Its history has never been written, and I am therefore glad, through the opportunity recently presented of observing its transformations, to be able to contribute the account to the still small number of life-histories of our insects which we possess. Such contributions, however humble, are always appreciated by true naturalists, and they form the foundation of our best economic work.

Oviposition of a Moth.

A female of *Tolype laricis* was taken at Bath, near Albany, on September 6th, resting on the trunk of a pine. Near it, upon the bark and but slightly raised above its rough surface, was the flat cocoon from which the moth had apparently but lately emerged. Under the presumption that its escape from the cocoon had occurred during the day, and that it had not therefore been visited by a mate, it was thought useless to attempt to procure eggs from it for rearing by confining it in a box, as is frequently done by collectors with many of the *Bombycidæ*. With a feeling of regret that the capture of so rare a species could not be made to contribute to the knowledge of its earlier and unknown stages, it was dropped in the cyanide (poison) bottle, preparatory to its pinning for the cabinet.

After lying in the collecting bottle for several minutes it was taken out and pinned. The box containing it and the other collections of the afternoon (*Catocala cara*, *C. concumbens*, *C. piatrix*, etc.), was set aside, from want of time for their preparation, until the following day. When the box was opened the *laricis* was found to have recovered from the effects of the cyanide, and to have commenced oviposition ; it had already deposited about twenty eggs in an irregular cluster. In the hope that the eggs may possibly have been fertilized, they were carefully preserved. Oviposition was continued during the two following days, and on the third, the moth was found dead — her abdomen shrunken to about one-fourth of its original size, the terminal tuft of hairs entirely removed (they were distributed over the eggs), and with the anal aperture distended to so remarkable a size as to make the insect an interesting specimen for the cabinet.

The Eggs.

The eggs, about fifty in number, remained in a cool room during the winter, and in early spring were placed upon my table. They proved to have been fertilized, and I was so fortunate as to detect their first hatching. It occurred on the 5th day of April, when two larvæ emerged. They hatched very unequally, and up to the 17th of April, thirty had appeared. The following are the observed dates of the hatching of additional larvæ: On the 17th, four ; on the 22d, four; on the 24th, one; on the 25th, two ; on the 28th, three ; on the 29th, two ; on the 30th, one, and the last — forty-seven in all : thus eggs deposited during three days (Sept. 7–9), were twenty-five days in giving out their larvæ (April 5–30).

FIG. 15.— TOLYPE LARICIS eggs.

The eggs are a glossy reddish-brown, broadly oval, somewhat flattened upon their attached side, about 0.05 inch long, by 0.04 inch broad; the surface, under a magnifying power of fifty diameters, shows irregular hexagonal reticulations, of which the elevated lines are divided by a fine impressed line. The shell is moderately thick. The larva eats an opening in one end of sufficient size for its escape, but in some instances a large portion of the shell is subsequently eaten. The eggs laid under my observation have been so covered with the anal hairs of the moth as almost entirely to hide them from sight. Fig. 15 represents a cluster of them.

The Larvæ in their First Stage.

The larva, on emerging from the egg, measures one-tenth of an inch in length, is of a dull green color, with a black dorsal line. The head, shown in Fig. 16, enlarged to six diameters, is brown, crossed centrally by a white horizontal line, another shorter one beneath parallel to it, just above the mouth-parts, and two nearly perpendicular ones on the superior front of the head, obsoletely united below by a curved line. Rows of tubercles traverse the body, from which long hairs proceed, of which those of the first segment are longer than the body, and those on the terminal segment are as long as the body. The legs are long, and project laterally — more conspicuously so when the caterpillar is walking. Twelve of the larvæ died during this stage before attaining their first molting. Their greatest length was one-fourth of an inch. This stage was of varying duration, extending from sixteen to thirty-three days.

Fig. 16.—Head of caterpillar of Tolype laricis in first stage.

Second Larval Stage.

The first molting commenced on April 21st, and terminated on the 8th of May, extending over seventeen days — a considerable less range than that shown in the hatching of the eggs (17:25). The following is the record of the observed moltings:

April	21	2 larvæ.	May	2	3 larvæ.
"	22	7 "	"	3	1 larva.
"	23	8 "	"	5	2 larvæ.
"	24	5 "	"	7	2 larvæ.
"	28	1 larva.	"	8	1 larva.
"	29	1 "			—
					33 larvæ.

On emerging from its first molt, the larva measured 0.3 inch. The frontal lines of the head, before nearly perpendicular and parallel, now converge below, resembling the letter U; the brown portions, under a

lens, show indistinct mottlings (see Fig. 17). The body tapers regularly from the first to the last segment. The dorsal line is brown, with pale borders. On the summit of the third segment is a fuscous patch, behind which, extending over the incisure, is a pale patch, convex in front and straight behind, bounded by the four tubercles of the fourth segment. On the seventh segment is a small pale patch. The sides of the body are gray, with irregular linings. A subdorsal row of black tubercles bear several long black hairs, beneath which is a dull orange interrupted line. The tubercles of the substigmatal row bear numerous shorter white hairs.

Fig. 17. — Head of Tolype laricis in its second stage.

During their rests from feeding the larvæ resort to the stems, where, with flattened body pressed to the surface and with head extended, they can scarcely be discovered.

At the close of this stage, which ranged from seven to eighteen days, the larvæ measured one-half an inch in length.

Third Larval Stage.

The second molting commenced seven days after the earliest of the first, and continued until May 9th, thus overlapping the first molt. The molts recorded (eight not observed) are as follows:

April 28	1 larva.	May 5	4 larvæ.
" 29	1 "	" 6	1 larva.
" 30	4 larvæ.	" 8	1 "
May 1	5 "	" 9	2 larvæ.
" 2	6 "		
Total			25 larvæ.

Immediately following this molting, the larva measures 0.55 inch. The frontal white lines of the head are more convergent, approaching a V, and some confluent lateral lines are seen resembling a B (not well shown in the figure), the brown portions are distinctly mottled, and numerous white hairs are given out from beneath the white transverse band (Fig. 18). The color and markings of the body are nearly as in the preceding stage. The subdorsal tubercles are more prominent and are slate-colored apically; two or three long black hairs proceed from each in a horizontal direction. The short gray lateral hairs are now so numerous, that they form a fringe to the body, which, as the larva rests on a leaf of the pine, curve downward and inward, so that some of the tips meet underneath. The subdorsal stripe is geminate, marked with orange opposite each tubercle. The tubercles of the third segment are more prominent than the others.

Fig. 18.—Head of Tolype laricis in its third stage.

Fourth Larval Stage.

The third molting, as in the second, commenced seven days after the earliest of the preceding molt, on May 5th, when but about two-thirds of the larvæ had undergone their second change. Of the duration of this molt, or of the dates of molting, no record was kept.

The larvæ show the following dorsal markings. Resting on segments 3 and 4, a sublenticular yellow spot, bordered with velvety black, and bisected by a narrow brown mesial line; on segment 7, a yellow spot of which the anterior portion is split by a wedge-shaped brown projection — its greatest breadth between the tubercles, extending on segment 8 and terminating in a point between the tubercles of this segment. In some examples, a somewhat similar shaped spot of paler yellow is seen on segment 9, extending a little on segment 10. The yellow lateral markings which in the former stage formed an interrupted line below the tubercles are reduced to a series of indistinct ochreous spots at the base of each tubercle. The cylindrical tubercles on segment 3 are quite projecting and rounded at the tip ; the subdorsal tubercles present the following ratio of size in the order of their occurrence : 1, 2, 7, 9, 6, 10, 5, 4, 12, 11, 8, 3 (that on segment 1 being the largest, and on segment 9 the smallest). The subjoint of segment 12 has two elevated black points. The barbed gray hairs composing the fringe have some barbless ones mingled with them. The legs are luteous, marked with black exteriorly, and are nearly hidden by the overlapping fringe.

Beneath, on segment 2, are three small mesial spots ; on segment 3 are two spots ; on the following segments, an obscure larger one mesially on each ring ; the body ventrally is marked with crinkled lines.

Previous to the fourth molting, the larvæ measure 1.2 inch. The 8th tubercle in the subdorsal row is conical; the 11th has a broad base, extending anteriorly to the incisure. Upon the first five segments the barbed hairs of the fringe are more numerous.

Fig. 19.—Head of Tolype laricis, female, in fourth stage.

This stage, as was ascertained later, was the last larval stage of a portion of the brood ; a part entered upon a fifth stage. The head of these, taken from cast head-cases at their fourth molting (enlarged to six diameters as the preceding ones), is represented in Fig. 19.

Mature Larva.

The largest attained a length of nearly one inch and a half. The color is a dull brown, resembling that of the bark of the pine twig. The head is covered with black hairs superiorly, and with gray hairs

anteriorly. When extended, the front of segment 1 is pale green, and the incisure of segments 2–3 is shining black. The three dorsal spots are pale greenish-yellow; the central spot, on segment 7, has a *fleur-de-lis* form; the following one, on segment 9, is small and geminate; and on segment 11, in a number of the larvæ, is a fourth spot, usually smaller than the preceding. Of the tubercles, arranged in subdorsal rows, those on segment 8 are the largest, exceeding in height and diameter of base those on segment 2, and are directed somewhat backward. A lens shows short hairs over the body, and on the summit of the tubercles are larger ones, curving inward; the body is lined with short, black streaks. From the tips of the lappets long, black hairs of an unequal length are given out, while their margins and intervening portions of the body bear numerous shorter gray hairs, many of which are barbed; these form a fringe directed downward when the larva is resting on a small branch, wholly concealing the legs and nearly hiding the long prolegs. In addition to these lappets (a substigmatal row), there is a single one of a little larger size on the first segment, in front of the first spiracle, the hairs of which project along the side of the head. All the lappets are margined with a black line which is more distinct upon the anterior one: the first three point forward, the others backward. The larva has the power of elevating or depressing one or more of the lappets at pleasure: when in motion, they are borne horizontally; at other times, all but the thoracic ones are depressed. The prolegs are obscure greenish. The ventral region is of the same color, with a lenticular blackish spot on the first five segments.

The Cocoon.

The first cocoon was spun on the 17th of May, forty-three days after the earliest hatching of the larvæ. Within two days, seven cocoons were made: in all, thirty-three were obtained. For the reason that the twigs upon which the larvæ had been fed were of a small size and without the branches at the giving off of which the cocoons are usually placed, nearly all were spun upon the flat sides of the feeding cage, where they presented the appearance shown in Fig. 20: none were placed in the angles or corners. Their ground-work usually extended at some distance beyond the cocoon proper, for while its average length was less than one inch, that of the ground-work often exceeded one inch and a half. The cocoon is of a pale gray color, elongate oval, quite flattened beneath, its elevation being but about one-half its breadth, rough-

Fig. 20.— Cocoon of Tolype laricis, spun upon a flat surface.

ened externally, smooth interiorly, moderately firm and thick but diaphanous, composed of two layers of silk, which are usually more closely united than represented in Fig. 21, which shows the under surface with the thin lower layer forming the ground-work removed, disclosing the pupa-case from which the moth has emerged through the ruptured upper part of the cocoon.

The Pupa.

The pupa is dark-brown, about 0.60 inch long, from 0.27 to 0.30 inch broad across the wing-cases, and only about 0.18 inch thick, being much flattened beneath. The incisures are deep and the segments well rounded, and continuing broad in the female, as shown in the figure, until their abrupt termination. The anal segment is tipped upon its upper side with two minute sharp teeth or by a bifid tubercle having a small granulation (shown under a lens) on each side. The male pupa is readily recognizable by its narrower terminal segments, and the well-defined antennæ cases showing at the point of the antennal twist a sensible contraction, and above it a broad lobe-like expansion, outwardly beyond the regular curve of this portion of the pupa. The features of the female pupa are essentially shown in the pupa-case, represented within its cocoon, in Fig. 21.

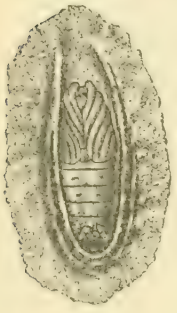

Fig. 21. — Pupa-case of Tolype laricis, within its cocoon, seen from beneath, with lower surface removed.

Pupation.

The pupation was quite brief — only twelve days, if three days be allowed for the change within the cocoon of the larva to the pupa. The first moth emerged June 1. The following is the record of dates of emergence of the thirty-three examples obtained: it is of interest in not showing the priority in the time of the male, which is found in many lepidoptera, but a singular alternation between the sexes of the first half of the brood: —

	♂	♀
June 1		1
" 4	1	
" 5		3
" 6	3	
" 7		3
" 8	2	
" 9		3
" 11	1	2
" 12	2	
" 13		1

	♂	♀
June 14	2	1
" 15	1	
" 16		2
" 17	1	
" 18		1
" 19	1	
" 20	1	1
Total	15	18

The Moth.

Dr. Fitch has given an excellent detailed description of the moth, which, in consideration of the small edition of the Report published and its scarcity at the present time, we herewith present :—

"The MALES [represented in Fig. 22] measure 0.60 inch in length to the tip of the abdomen and of the wings, and one inch across the latter when they are spread. The head is densely clothed with white hairs in front and with blackish ones upon each side around the eyes. The feelers are minute and are wholly enveloped and concealed by fine long hairs, their ends forming a slight projection, like the point of a camel's hair pencil. These hairs are blackish on their outer sides and ash-gray within. The antennæ are short, about a third of the length of the body and are abruptly bent near their middle,* or with the ends straight in both directions from their crook near their middle, when they present the shape of an inverted V. They are furnished with two rows of coarse branches, which are long from the base to the crook, where they are abruptly shortened to half their previous length, and continue thence to gradually diminish in length to their tips. Each branch has a row of very fine hairs along one side resembling eye-lashes. The mouth has only the minute rudiments of a spiral tongue, and this not coiled as we see it in moths generally. The thorax is clothed with long hairs of a dark gray color, those at its anterior end white, and on its posterior part is an oblong crest of glossy scales, slender and hair-like, with their ends dilated into an oval, flattened knob, in shape resembling a spoon, of an auburn-brown color, arranged like the hairs of a moustache, and jutting up from the surrounding prostrate hairs, forming a large tuft or protuberant oblong spot, broadest posteriorly and narrowing to its anterior end. The abdomen tapers slightly from its base to the tip, and is clothed with blackish hairs above, whitish ones beneath, its apex having a dense tuft of long, pure white ones. The wings are quite small for such a thick-bodied, heavy moth. They are semi-transparent, being thinly covered with brown scales which are commonly denuded, the wings then appearing perfectly transparent, like glass. Their veins are robust and white, with darker, irregular bands. The hind margins of both pairs of wings are entire and not in the least

FIG. 22.— Male of the Larch lappet-moth — TOLYPE LARICIS.

*This feature is not shown in the figure.

toothed or scalloped. When at rest they are pressed against the sides of the abdomen, in the form of a steep roof, the outer edges of the hind wings protruding more or less from under the outer edge of the fore ones. The legs [which are stretched forward at rest] are heavily clothed exteriorly with tufts of long, snowy-white hairs, the forward shanks having a tuft of blackish ones on their insides at their base.

The female, shown in Fig. 23, is quite unlike the male, being much larger and differently colored. It has a peculiarly delicate or mellow appearance, from the softness of its colors and the thinness and translucency of its wings. The latter, when extended, measure an inch and a half or slightly less. Their hind edge is occupied by a slender white band or line. Forward of this is a narrow, pale, dusky band which is abruptly widened near its middle to double its usual breadth, this widened part occupying two of the interstices between the veins. This band is margined on its anterior side by a white line, by which it is separated from a much broader and more dusky band, which is waved in its middle in conformity with the dilation in the narrow band behind it. Forward of this the wings are milk-white, crossed by four very faint, equi-distant, wavy bands of the same delicate, pale, dusky hue with those behind, these bands being often obsolete on the middle of the wing and distinct at their ends only. The veins are prominent and white, forming slender lines of this color crossing all the bands. The hind wings are of the same soft, dusky tint as the bands on the fore-wings, but more pale; on their hind margin is a white line or slender band. The hind edge of both pairs of wings is perfectly entire as in the male, and their fringe is pale dusky on the fore-wings, crossed with white lines at the tips of the veins. The body is clothed with incumbent milk-white hairs, the tip of the abdomen having a pale brown tuft, and the crest on the base of the thorax appears like a large, elevated, blackish spot. The antennæ in this sex are very slightly crooked in their middles, and their branches, though equally thick with those of the males, are much shorter, being about four times as long as the diameter of their stalk. These branches are longest in the middle, and are gradually shorter from thence, both toward the base and the tips."

FIG. 23.—Female of the Larch lappet-moth.

Sexual Difference in the Larval Moltings.

It has been my habit to preserve all the head-cases cast off at the several moltings of the lepidopterous larvæ reared by me from the egg, to serve as a tangible record of the number of molts undergone, and for the further reason that they usually present interesting specific features which render them valuable for illustration, and for preservation in a biological collection. In collecting the head-cases of the above brood of *T. laricis*, I was at a loss to account for the great deficiency in number of those of the fourth molt. There were fifteen less than in the preceding molt. When the moths had all emerged — equal in

number to the number of the cocoons — it was found that there were fifteen males and eighteen females. The mystery of the deficient head-cases was solved. The fifteen male larvæ had spun up in their cocoons after three molts, and the females had undergone an additional molt before maturing and forming their cocoons.

That a female moth may undergo one molting more than the male had been before noticed. Prof. Riley records it as the rule in the development of *Orgyia leucostigma*, the white-spotted tussock moth, which deposits the white froth-coated egg-masses upon the trunks of the elm and horse chestnut trees, which its caterpillars injure so seriously and often defoliate in Albany and other of our cities. Of this species he states* that the male caterpillars spin up in cocoons about six days before the females, which continue their growth until they attain about twice the size of the males.

An additional molting of the female *Orgyia antiqua* Linn., in England, has recently been recorded (*Ent. Month. Mag.*, xix, p. 210).

Observations made by me during the last summer render it almost certain that this same sexual difference in the moltings exists also in *Callosamia Promethea* (Drury). The cocoons which I have in my possession, obtained from a brood of larvæ raised last summer, will permit of a positive determination on this interesting point.

Annual Broods.

There are two annual broods of this species. The hibernating eggs produce moths in June and July, which at once deposit eggs to give the second brood of moths in the month of September. I have captured them, at rest upon trees, at different times between the 1st and 6th of September. Eggs of the first brood, obtained during the first week in July, showed some black spots on the 9th, depressed sides on the 12th, and changed to a pearly-white color a day before their hatching on the 19th.

Distribution.

It does not appear to be a widely distributed species. It is known to me only from New York and the New England States. It seems to be much more rare and limited than its longer known congeneric species, *Planosa velleda* Stoll, which is occasionally met with upon apple, elm, and a few other trees, throughout the Eastern and Middle States, extending into Georgia (Smith–Abbot), Kansas (Snow), and Illinois (French).

Remedies.

The rarity of this insect renders it unnecessary to indicate means for its destruction. It probably will never appear as a pest, unless a

**First Report on the Insects of Missouri*, 1869, p. 145.

colony should take possession of a small evergreen prized as an ornament. In this event, its presence would be shown by the closely eaten leaves, when the larvæ should be sought for resting upon the trunk during their repose by day, and *if discovered* (which is extremely doubtful, for reasons previously shown), if they could be induced to release their hold to the bark, they might be boxed and sent to some entomologist, who would gladly undertake to arrest all further injury from them or their descendants for all future time.

Nephelodes violans Guenee.

Larva: *The bronze-colored cut-worm.*

Moth: *The Violet Nephelodes.*

(Ord. LEPIDOPTERA: Fam. NOCTUIDÆ.)

GUENÉE: Sp. Gén. Lép, v.—Noct., i, 1852, p. 130, no. 204 (original description).

LINTNER: in 23d Rept. N.Y. St. Cab. N. H., 1872, p. 194; in 26th Rept. N. Y. St. Mus. N. H., 1874, p. 180; Ent. Contrib., iv, 1878, pp. 34, 46, 49, 119 (dates of collections, etc.); in 7th Rept. Adiron. Surv. St. of N. Y., 1880, p. 385; in St. Lawr. Repub., June 8, 1881; in Country Gent., June 9, 1881, xlvi, p. 375; in Albany Eve. Journ., July 1, 1881.

SNOW: in Trans. Kans. Acad. Sci., iv, 1875, p. 45 (common in Kansas).

NORMAN: in Canad. Entomol., viii, 1876, p. 69 (moth common in Ont.); Id. vii, 1875, p. 6.

THAXTER: in Psyche, ii, 1877, p. 36 (occurrence in Mass.).

FRENCH: in Prairie Farmer, April 6, 1878; in Thomas' 7th Rept. Ins. Ill., 1878, pp. 99, 220 (description of larva and moth and habits); in Canad. Entomol., x, 1878, p. 61 (description of larva and pupa).

FORBES: in Amer. Entomol., iii, 1880, p. 231 (larva from blue bird).

RILEY: in Amer. Nat., xv, 1881, pp. 575–577 (larval habits and description); in Amer. Entomol., iii, 1880, p. 205 (habits, etc.).

OSBORN: in Iowa Homestead, June 17, 1881 (diseased larvæ).

The caterpillar of this species was associated with that of *Crambus vulgivagellus* in its attacks upon the pastures of St. Lawrence county, N. Y. (noticed in the following pages), and probably, in other of the adjoining counties. The association, however, was rather one of time than in depredations, for, from the habit of the caterpillar of concealing itself by day under some object lying upon the ground, and coming out at night for feeding, it is not at all probable that its injuries would extend to any distance from its hiding place or embrace the entire area of a pasture or meadow, as did those of the Crambus larva. Its favorite hiding places seem to be pieces of wood, such as fence-rails, and the excrementa of cows. In proportion as these abounded in grass-land, in a like proportion might its depredations be distributed.

The Caterpillars in St. Lawrence County.

A few of the caterpillars (not more than four or five examples) were among my collections in the towns of Canton and Potsdam, on May 19th and 20th. Upon my return to Albany, when it was found that nearly all of the Crambus larvæ which I had collected, had died, and it was doubtful if any would mature, in compliance with my request for additional specimens, a box of fifty or more larvæ was sent to me, with the following interesting statement of their abundance, under date of May 23d.*

"Last Saturday (21st), the farmers reported that the caterpillars were dying, as they found the dead skins *under the ground*. This morning I went to our pasture to see if this was so. I found comparatively few such as were seen last week, but under every stick I turned, except two, were larvæ, such as sent by express to you to-day, together with cast-off skins of last molt. It appears, therefore, that instead of dying, they were molting. Under about twenty sticks I found one hundred larvæ such as sent, some few of 2d and 3d molt [*C. vulgivagellus*], and three of other Lepidoptera."

They were large, stout, caterpillars, as represented in Fig. 24, of from one inch and a quarter to rather more than one inch and a half in length, with a yellowish head, a broad pale band upon the sides in which are the breathing-pores (spiracles), and in the most distinctly marked examples, with five additional lines upon the back and sides, more or less distinct. Their general color was of an olive-green.

Fig. 24.—Caterpillar of the Violet Nephelodes—Nephelodes violans, — natural size.

That it was thought at the first, both by my correspondent and myself that these might be but an advanced stage of the forms previously collected,† may find excuse in that it was expected that the latter had still one or two molts to undergo before attaining their maturity. Such extensive depredations as observed had been mentally associated with a species at least as large as *Leucania unipuncta*, and to attain this size two additional moltings would be required. It was not thought that they were near maturity; when, therefore, they so suddenly disappeared, and at the same time, another form was discovered in large number, together with their cast skins, it was but natural to accept the two phases as the

*For these examples, for additional sendings, for valuable observations, communicated to me from time to time, upon this species and *Crambus vulgivagellus*, and for first conveying to me the information of the abundant presence of these species, and for many other similar favors, I desire to express my deep obligations to Miss A. Clarkson, of Potsdam, New York.

† For an account of these collections see the pages upon *Crambus vulgivagellus* larvæ.

result of an intervening molt, particularly, as changes are known to attend the moltings of some species, quite as marked, in general appearance, as were these. The suddenness of the replacement of the forms is shown in this fact stated in a letter of Miss Clarkson to me: "When you were here (20th inst.), the striped larvæ were one to hundreds of the spotted, while on the Monday following (23d), it was just the other way."

A few days later (May 27th), my correspondent wrote me: "This morning I found fourteen of the caterpillars under a piece of fence-rail about four inches wide and four feet long. They are also found under leaves, stems and dried excrement. The grass around their hiding places is eaten off at the top."

Unsuccessful Attempt to rear the Caterpillars.

The caterpillars sent to me, as above stated, were received May 25th, and placed in a large tin vessel where they were furnished daily with a supply of fresh grass. On June 1st several of the larvæ had matured and entered the ground contained in the case for pupation, while others took position in shallow cells which they had excavated beneath a paper covering the surface of the ground. By the 8th of June all of the larvæ had ceased feeding. They were observed daily, but it was evident that the conditions of confinement were unfavorable to their development. Dead ones were removed from time to time from their cells beneath the paper, while others, but slightly changed in appearance, still occupied the cells on July 1st. At this time a large dipterous parasite, enveloped in some silken threads, was found upon the ground. Wishing to take the larvæ with me upon leaving home, on July 16th, the ground was turned out and examined, when, with a number of dead, one pupa was discovered, one still unchanged larva, four cocoons of a species of ichneumon, and one of apparently a different species. The pupa died, and I failed to secure a single moth.

With a second sending of fifty larvæ on June 4th, I was equally unsuccessful. Nearly one-half of the number were still feeding on June 8th, at which date one example passed its last larval molt. On the 25th those that survived were occupying cells within or on the surface of the ground, but were uncomfortable from the presence of a large number of a minute, white, agile species of the Podurinæ which infested the earth and could be seen upon their bodies. The insect was believed to be *Campodea fragilis* Meinert, figured in the *American Entomologist*, vol. iii, p. 199, f. 104, but it was not positively identified. For the purpose of freeing the larvæ from these pests, they were removed to a box containing dampened paper. The moisture proved

insufficient for them, and two days later the larger number were found dead.

Some of the larvæ were sent by me to Prof. Riley, at Washington. They were at once identified by him as a species with which he had been familiar in Missouri, and from which he had bred the moth known as *Nephelodes violans* Guen. He had found it extremely difficult to rear in confinement, and only after repeated failures was he successful in carrying the caterpillars through to their perfect stage. In a recent reference to the caterpillar, as having been found in the stomach of a blue-bird shot in Normal, Ill., he had characterized it as "the bronzed cut-worm."

Description of the Larva.

Prof. Riley, in compliance with my request for such of his MS. notes as he might spare me for publication, has kindly sent me the following description of the early stages of the caterpillar:

"The larva in its *first stage* is bright green with the head pale gamboge-yellow, the cervical shield of the same color, and the three narrow dorsal pale lines and broader stigmatal pale stripe almost white, and not showing on the plates. The intermediate faint line between the subdorsal and stigmatal stripes is obsolete, and the space between all the lines is more nearly equal than in the last stage, the stigmatal stripe extending above the stigmata where later it becomes purely substigmatal. In the *second* stage there is little change, but in the *third* the lines show through the plates which become darker. The piliferous spots which subsequently become subobsolete are in the earlier stages dark and more conspicuous and normal, and the front prolegs are never atrophied."

The following description of the young larva, giving mainly colorational features not contained in the above, and also of the mature form, is published by Prof. Riley in vol. xv of the *American Naturalist*, pp. 576–7.

"The young larva is green but early shows the pale stripes. When about one-third grown the general hue is olive-green with the cervical and anal plates but little darker. The head is pale greenish, faintly freckled, and with a few dark hairs; the sutures pale, the mandibles tinged with blood-red, and brown at extremities, and the ocelli distinct on a pale ground, the second and third from below, black, the others light. The three dorsal stripes and the narrower suprastigmal line are very pale greenish-yellow, the broader substigmatal stripe of a clearer cream-yellow with a faint carneous tint.

"*Mature larva*:— Larger specimens fully 1.9 inch long, largest in the middle of the body and tapering slightly each way, especially toward anus. Color, brownish-bronze, the surface faintly corrugulate but polished, the piliferous spots obsolete. A darker, highly polished cervical shield and anal plate. A medio-dorsal and subdorsal stripe of a buff, or dull flesh-color, each stripe of about equal diameter (nearly 0.04 inch on middle joints), forming narrower, paler lines on the plates and nearly converging on the anal plate; a similar but somewhat broader substigmatal stripe which is wavy below; between subdorsal and

stigmatal stripes a faintly indicated pale line dividing the space nearly equally. Venter nearly of same buff color, with a tinge of green. *Head* perpendicular, immaculate, paler than body, rugulose, sub-polished, faintly translucent, pale dingy-olive, the jaws, and sometimes the mouth-parts, darker. Legs and prolegs of same pale olive color, the latter with a black band at outer base. Stigmata black.

"One of the most marked Noctuid larvæ, at once distinguished from all others known to me when full-grown by the pale immaculate head (recalling copal) and the polished, bronzy or umber color of body. The upper stripes are often obsolete or sub-obsolete in the middle of body, but are persistent on the plates. The bronzy color in paler specimens is due to brown and yellow mottlings, and in dark specimens becomes nearly black, while the spots are generally minutely mottled with carneous.

"*Pupa:*— Normal dark brown, the tip with two horizontal, almost parallel, spines."

Notes of the Occurrence of the Larvæ.

The following larval observations, made by Prof. Riley, in Missouri (except the last two), have also been placed in my hands for use in this notice of the species:

April 24, 1871. Found under rock, apparently feeding on clover. Tolerably common around Kirkwood and along the Iron Mountain Railroad, nearly full grown. Curls sidewise.

April 25. It feeds on grasses, clover, *Polygonum aviculare*, and appears to take most of the succulent plants.

May 5. Found the same rather common at Columbia, Mo., on soil, under plank and under shelter, in different sizes. Occurs with quantities of its pale bright green frass. On the 8th, others were found at Kirkwood.

May 19. One nearly full-grown was discovered high up on a stalk of blue grass, feeding in the hot sun (exceptional).

May 28. Of nineteen specimens placed in a vivarium and others under a sieve out of doors in a meadow, several proved to have been parasitized; one had nineteen Tachina eggs upon it; another gave forth Microgaster larvæ which had spun their white cocoons in a surface cavity in the ground made by the larva, and still another gave an Ophion cocoon. The healthy ones have all entered the ground but are still in the larval state.

June 22. The larvæ are still unchanged.

Sept. 3. Sieved the ground and found all changed to the pupæ. Two days later the first moth emerged, and others issued subsequently.

May 1, 1873. The season backward (apple blossoms just out). Found the larvæ of different sizes, — some quite young and others full-grown.

April 26, 1876. The larvæ are quite common on St. Louis Fair grounds.

June 29, 1880. One larva from the stomach of a blue-bird (*Sialia sialis*), received from Professor S. A. Forbes, of Normal, Ill.

April 30, 1881. The larvæ not uncommon in ground at base of rocks on High Island, near Washington, D. C.

Published Observations upon the Larvæ.

Very little has been published of the habits of the larva. Prof. Riley, in vol. iii of the *American Entomologist* (p. 215), in noting his identification of it in the stomach of a blue-bird, states:—

"We have been familiar with it for many years, having reared it in 1871, after many previous futile efforts. It is quite common in Northern Illinois and Missouri in early spring, when it may be found in blue-grass sod, generally concealed under some stone or board during the day, though we have occasionally found it feeding on grass stalks in the hot sun during the day time. The larva is found full-grown as soon as spring opens, so that it undoubtedly passes the winter, like so many other cut-worms, in the larva state and of different sizes. The insect is quite common and wide-spread, for we have found that the larva had been common in 1871 around Ithaca, N. Y., on blue-grass and under clover."

The larva was first described by Prof. French, Assistant State Entomologist of Illinois, in the Canadian Entomologist, vol. x, April, 1878, from examples found by him during the last of April and through the month of May, in grassy places in Washington county, Ill. These changed underground, early in June, to dark brown pupæ, from which the perfect insects were obtained about the middle of September.

While in confinement they fed freely upon corn, grass and *Polygonum aviculare*, which they ate without seeming to prefer one more than another.

In Dr. Thomas' *7th Annual Report on the Insects of Illinois*, Prof. French includes the species in an account there given of several corn depredators, stating: "As corn forms one of the food-plants of the caterpillar, it may be placed here among corn insects, though the extent to which it may injure corn is unknown, for I fail to find any record of the insect, except in its moth state." He found it to possess, when fed in confinement, the same habits as those of the larvæ of *Agrotis* and allied genera, and therefore suggests the name of "the smooth cut-worm" for it. The first specimens were found April 28th, concealed in the grass, at which time it was almost an inch long and of nearly a black color. During the month of May, others and larger and of a lighter color were found, the features of which are described, and some observations upon their habits in confinement given. He adds in concluding: "Should they multiply so as to be destructive to

corn and grass, burning our meadows and fields late in the spring would doubtless destroy them."

In the same report, p. 220, Prof. French also devotes a page to the species, giving description of the larva and of the moth.— He adds: "I have no evidence that this insect ever becomes sufficiently numerous to be injurious, but as it seems to be a general feeder upon some plants that are beneficial to man, and as it is spread over a wide range of country, it may do so. In that case, we may judge from its cutworm habits that the remedies that serve to keep them in check will also answer for this."

Prof. Osborn, of the Iowa State Agricultural College, has given an interesting account of a diseased condition of the larvæ, which came under his observation. He states (*loc. cit.*):—

"*Nephelodes violans* has been quite numerous in localities around the college, though its damage has not been very perceptible. It is attacked by some epidemic disease, which causes the death of large numbers of them. The diseased worms will be found clinging to the grass as high up on the stems as they can reach, their bodies swelled to an unnatural size, and in the later stages exceedingly soft and ready to fall to pieces. If undisturbed, and the weather dry, they finally shrink away and only the dried skin and a mass of blackish matter within it, remains. If examined at any time after they begin to show the symptoms of disease, their blood will be found full of minute living organisms (*Bacteria*), which seem to increase in numbers as the disease progresses. They are also found even more abundantly in the fluid taken from the alimentary canal. We here meet with the great question which is so perplexing to the medical profession, whether the microscopic animals are the cause of the disease, or an attendant or consequent of it. * * * * We have the fact, and a gratifying one, that *some* disease destroys great numbers of this insect, which otherwise might cause great destruction to various important crops."

In a paper recently published by Professor Forbes, State Entomologist of Illinois, upon the *Regulative Action of Birds upon Insect Oscillations*, he records the larva of *N. violans* as constituting a portion of the food of robins (*Turdus migratorius*), catbirds (*Mimus Carolinensis*), and red-winged blackbirds (*Agelaus Phœniceus*), shot in an orchard in Tazewell county, Ill., during the latter part of the month of May, for examination of the contents of their stomachs. (*Bull. Nutt. Ill. State Lab. of Nat. Hist.*, 1882.)

The Moth.

The moth is represented in Fig. 25. It is a stout, robust form, and rather above the average size of the *Noctuidæ*. In spread of wings it usually measures between one inch and a half and two inches. The general color of the front wings is brown, with a violet reflection. The two transverse bands, inclosing a darker space of brown traversed by the median band and having in its upper portion in paler color the two ordinary spots, and the subterminal line, are indistinctly visible. All the markings are obscure. The hind wings are brownish, paler at the base. More carefully noticed, the moth presents the following features: —

FIG. 25.—NEPHELODES VIOLANS Guenée. Natural size.

The expanse of wings of the male is 1.65 inch; of the female 2 inches. The primaries are broad and stout, triangular, rather squarely cut at the apex, with the spots and lines indistinct. The two transverse lines are visible, of which the anterior (nearest the base) is undulated and arcuated, and the posterior one is rounded over the end of the cell; between the two is a median shade, rather indistinct. The subterminal line is sinuous, angulated on each nervule, and sometimes forming a W on the upper nervules of the median vein as in *Hadena*. The color of the wings is brown (*chocolat-au-lait*), suffused with violet, with the space between the transverse lines (except upon the costal and internal margins) deeper brown, especially behind the reniform spot, which is of the usual kidney-shape; the orbicular spot is round; they are both illy defined, are concolorous with the subterminal space, and are often lost superiorily in the pale costal margin. The fringe is of the same color as the wing.

The secondaries are obscure gray-blackish in both sexes, of rather uniform shade, but a little paler at the base. The fringe in some fresh examples is reddish-violet. Their underside is of the latter shade with a median line and a lunule in the cell.

The abdomen is long, stout, carinated, tufted, and robust; quite large in the female, in which it is cylindrical, and terminates in an obtuse point. The thorax is square, stout, hairy, the breast is quite hairy. Legs, with the femora quite hairy, and the tibiæ stout, not spined, scaly rather than hairy. The antennæ are stout, demi-pectinated, *i. e.* furnished with pubescent teeth, and terminating in a stiff hair in the male; slender, filiform (with isolated hairs) in the female. Palpi obliquely ascending, the second joint thick, bristling-hairy, the third slender, short but distinct, directed forward. Proboscis short.

The above description is mainly drawn from the specific characters given by Guenée, combined with those characterizing the genus, which

embraces but two other species, viz.: *N. minians*, occurring with *N. violans*, and *N. rubeolans*, doubtfully from New Holland.

The moth is not numbered among the common species. Ordinarily, so far as my observation extends, it is rather rare, but in the year 1876 it was somewhat abundant in the vicinity of Albany, and Mr. W. W. Hill captured, at Bath-on-the-Hudson, forty examples between August 30th and September 15th, where it had not occurred during several preceding years. Mr. George Norman records it as "common at light and sugar," in his *Captures of Noctuidæ at St. Catharines, Ontario*, in 1874. In his paper on *Captures of Noctuidæ near Orillia, in the Province of Ontario, Canada*, he represents it as very frequent at light, rest, and sugar;" the locality is near Lake Simcoe, in lat. 44°. Mr. Hill, in his Adirondack collections during the years 1875–1878, captured but five examples (all males), occurring between Aug. 3d and Aug. 22d: in some of these years collections were not made during September when the species may have been more numerous. The earliest date at which I have taken the species is Aug. 2d — the latest, Sept. 11th. I had never found it otherwise than rare until the year 1877, when it was not at all uncommon among the very large collections made, by sugaring, at Center, N. Y.

An interesting fact in regard to this moth is the worn condition in which it always presents itself to our notice. I have never seen a perfect specimen — all have been rubbed more or less over portions of their wings, their fringes broken, and colors dulled. Not having reared the species from the larva, all have been flown examples, but, without doubt, some had been but a short time from the pupa. Of many other species, I have captured abroad and at sugar, hundreds of examples in such condition that the most critical collector would not hesitate to call them *perfect*. The uniformly worn condition of *N. violans* has often been remarked upon, but no satisfactory explanation has been given for it. Mr. Norman, in his list of one hundred and seventy-four species of Noctuids occurring at Orillia, says of this, as of no other species, "always in bad condition." Mr. Thaxter, in an extended list of species, also singles it out for the comment, "almost always in poor condition."

Guenée, in describing this species, suggests that it may possibly be but a local variety of the species which he describes at the same time under the name of *Nephelodes minians*. The two have been regarded as identical by some of our writers and they are catalogued as *N. minians*, and var. *violans* in the new check-list of Mr. Grote, but from the differences shown by examples in my cabinet and in those of Mr. Meske and Mr. Hill, in Albany, where they are arranged as distinct species, I shall regard them, for the present, at least, as distinct. In

N. minians, the darker space between the transverse lines is of a dull red color; the anterior transverse line is less curved and the front wings are broader and less produced apically than in *N. violans*.

Distribution of the Species.

The species appears to have a wide distribution over the United States. At present we know it from Massachusetts, Michigan, Wisconsin, Illinois, Missouri, Kansas, and some other of the Southern States. It probably occurs in Washington Territory, as *N. minians* is reported as having been taken there. In Ontario, the moth has occurred more frequently than in the United States.

Its Natural History.

The moth may be seen abroad as early as the first of August, in favorable seasons, and it continues until the latter part of September. According to Prof. Riley, it not infrequently hibernates as a moth in the Southern States, where it has been observed at different times during the winter months. We have no knowledge of its eggs. They are probably deposited upon the grass near some object which may serve as a hiding-place for the young larvæ. The time of their deposit is unknown, but from the facts given (see p. 103) of nearly full-grown larvæ having been seen as early as April 24th (in Missouri), and full grown ones on May 1st, we may safely infer that oviposition takes place soon after the appearance of the moth in August or September, and that the young larvæ, after eating sparingly, and having undergone at least two molts, retire to their hiding places wherein to pass the winter. Those that survive this perilous period of their existence — perhaps a small proportion of the original number — resume their feeding as soon as the grass starts in the spring.

The habits of this caterpillar place it in that destructive class known as "Cut-worms," of which so much has been written, and which are justly a terror to agriculturists from the secrecy of their depredations and extreme difficulty of arresting them. The name of cut-worms was originally given to those species which were addicted to cutting off the stalk of young cabbages, turnips and other plants just at or beneath the surface of the ground. As now extended, it embraces those numerous species which conceal themselves during the day either beneath some object lying on the ground, or buried just below the surface, and come abroad at night to feed upon garden vegetables and other low plants. Some of the species, not confining themselves to low vegetation, climb trees, grape-vines, etc., to feed upon the buds and tender leaves. Instead of the omniverous and ubiquitous *cut-worm* of early writers, upon which was charged vastly more than any one insect should be called upon to bear, we have now

perhaps three hundred species, each needing special investigation, and many showing habits differing so greatly from one another, that very different methods of treatment are required for their destruction, or for the prevention of their injuries.

In my own experience with the larvæ of *N. violans*, they developed no cut-worm habits, as they were fed in darkness under cover with cut grass furnished them. Prof. French observed them in an open rearing box and found them to display the same habits with the larvæ of the genus *Agrotis*, feeding mostly at night and keeping concealed during the day, either in the ground or under the loose material upon it. They were sluggish in their movements, except when disturbed, when they were quite active. In Illinois (see p. 104), the larvæ entered their pupal state in June; in Missouri, the larvæ had matured and buried for pupation previous to May 28th; in New York, the earliest matured June 1st and the latest about the 20th, giving for the average time, June 10th. On July 16th one was found to have pupated — how long previously is not known. The larvæ evidently, after burying in the ground, remain unchanged for a longer time than most of the *Noctuidæ*. Thus Prof. Riley found examples unchanged about a month after they had entered the earth, but it is possible that these may have been diseased or parasitized. It is probable that the interval between maturity and pupation does not exceed a month, and is less than one-half that which has been observed in its late associate, *Crambus vulgivagellus*.

They continue a long time in their pupal state — the moth not appearing until the end of summer, leaving no time for a second brood. Prof. French gives the species a pupation of between two and one-half and three months in length, but from other observations, it appears as if his statement of "they went into the chrysalis state in June," might properly be amended so as to read, "they entered the ground for their pupation in June," which would permit the period as above given to be shortened a month.

Parasitic Attack.

The larvæ appear to be very subject to parasitic attack. Those that I attempted to rear gave me quite a number of dipterous puparia, of which I have failed to secure the fly, although some of them have emerged. The puparium is quite small, measuring but 0.22 of an inch in length, and indicates a species smaller than any of the Tachina flies known to me. The larvæ must have been parasitized previous to their final moltings, as none of the egg-shells were observed upon them. A large hymenopterous larva which escaped from one of the caterpillars, died without forming its cocoon. Prof. Riley

mentions (page 103), that the species is parasitized by a Tachina fly, and by one of the Hymenoptera, of the genus *Ophion*, and by another minute hymenopterous insect — a species of *Microgaster*. These parasites have not, I believe, been specifically determined.

Preventives and Remedies.

It is not probable that this species will often occur in such numbers as during the last season, or that it will often prove very injurious. Whenever it shall do so, the means that are recommended for preventing the ravages of the vagabond Crambus will prove equally efficient against this insect. Some of the applications there proposed to be sown over the grass will doubtless serve to protect grass lands from their depredations. Deep plowing in the autumn after the usual places for harborage have been removed, would destroy the young larvæ. Simply burning over the surface might fail to reach many of the larvæ in their retreats beneath stones, logs, etc. The moths are attractable to sweetened substances, as collectors have found in their sugaring operations, and numbers of them, when just from pupæ, may be drawn by a light to a bait of molasses and vinegar, in which they will be caught and drowned. This lure for them should be used during the months of August and early September. Rolling the ground after nightfall would be destructive to them and to other associated nocturnal feeders.

Other means known to be effectual in destroying cut-worms in grass lands might be equally successful with this species.

Gortyna nitela Guen.

The Stalk-borer.

(Ord. LEPIDOPTERA : Fam. NOCTUIDÆ.)

GUENÉE. Sp. Gén. Lép., v. — Noct. i, 1852, p. 124, no. 195 (original description).

HARRIS. Ins. Inj. Veg., 1862, p. 440, f. 219 (larva figured and described but not identified); Entomolog. Corr., 1869, p. 315 (in potato stalks).

RILEY : in Prairie Farmer, Feb. 23, 1867; 1st Ann. Rept. Ins. Mo., 1869, pp. 92, 93, figs. 35, 36; 8th Rept., 1876, p. 37, f. 23; in Prairie Farmer, Aug 11, 1877; Potato Pests, 1877, p. 91; Gen. Ind.-Suppl. Mo. Repts., 1881, p. 56.

WLSH.–RIL. : in Amer. Entomol., i, 1868, p. 22, fig. 11 (food-plants and transf.); Ib., 1869, p. 206, f. 140 (in peach); pp. 228, 249 (in tomato); p. 252 (in corn); Id., ii, 1869, pp 42, 64 (food-plants).

PACKARD : Guide Stud. Ins., 1869, p. 310, f. 241; in 9th Ann. Rept G.-G. Surv. Terr. for 1875 (1877), p. 719, pl. 65, f. 6 (brief notice)

LE BARON : Second Rept. Ins. Ill., 1872, p. 141, figs. 1, 2 (in wheat).

SMITH : in Thomas' 7th Rept. Ins. Ill., 1878, p. 112 (general notice).

FRENCH: in Seventh Rept. Ins. Ill., 1878, p. 221 (in corn).
LINTNER: in Count. Gent., xliv, 1879, p. 503; xlv, 1880, p. 472; in 39th Ann. Rept. N. Y. St. Agricul. Soc. for 1879 (1880), pp. 48–52, figs. 1, 2.

An insect which had rarely, if ever, been known to exist in such numbers as to commit serious depredations, and which by its comparative rarity and the nature of its food-plants, had never been classed by entomologists among the injurious insects, may, from an inexplicable combination of circumstances and conditions, suddenly appear in so great number as to enlist general attention to its extensive ravages. No better illustration of this fact can be given than that afforded by recent demonstrations of the Orthopterous insect, *Diapheromera femorata* (Say), popularly known, from its long and attenuated body and limbs, as the walking-stick, skeleton-bug, spectre insect, etc. This species, which had long been regarded as harmless and comparatively rare, has within a few years past increased to such an amazing extent in certain localities in Vermont, New York, New Jersey, and elsewhere, as completely to devour the foliage of various kinds of trees over broad districts of woodland. In Yates county, New York, on the farm of Mr. G. C. Snow, their destructiveness, during the past six years, has been most remarkable, having entirely defoliated above twenty-five acres of hickory, oak, etc., and caused the death of a large number of trees. In their travels to obtain food, they covered the fences and the ground, and their closely packed bodies were a hindrance to their progress. For an extended and interesting account of their extraordinary multiplication at this locality, the report of Prof. Riley, contained in the *Annual Report of the Commissioner of Agriculture* for 1878, may be consulted.

Reference to the above insect has been made, prefatory to a short notice of occasional injuries to important crops, by the Noctuid moth, *Gortyna nitela* Guen., or the stalk-borer. This insect has not secured a prominent place in the list of insect pests, yet at intervals, in certain localities, complaints are made of serious depredations inflicted by it. More frequently, it falls under our notice as a borer in the pith of plants cultivated in our gardens, as in the stems of asters, dahlias, lilies, spinach, etc.

In the early part of July of last year, examples of the larva were sent to me for their name and best method of checking their injuries, from a gentleman residing at Monsey, Rockland county, N. Y. They had appeared in strong force in a potato field, and their burrows within the stems had caused a large number of the stems to wilt, and to break at holes which had been eaten into them, for the entrance of the larvæ or for the expulsion of the excrementa. The larvæ were fed by me some time in confinement.

They ate very greedily of the food furnished them, and having consumed the pith of a stem, they would emerge, and quickly eat their way through a round hole into another stem. They displayed remarkable activity in their movements. I failed in my efforts to carry them to maturity, through lack, doubtless, of a proper food-supply.

The habits of this insect, as a borer, in its larval state, in the interior of growing plants, were first brought to notice in the *Prairie Farmer*, of Feb. 23d, 1867.

Food-plants.

While many of our insects are confined to a single food-plant, and by far the greater number have a very limited range, this insect feeds on a large number of plants, differing greatly in character. In a notice of it by Miss Emma A. Smith (*loc. cit.*), the following list of plants, the stems of which it bores, is given: tomato, potato, spinach, wheat, corn, dahlias, asters, lilies, spiræa, salvia, milk-weed, castor-bean, rhubarb, *Chenopodium* sp., peach twigs, currant twigs, cockle-bur (*Xanthium strumarium*), rag-weed (*Ambrosia artemisiæfolia*), and a variety of hearts-ease (Polygonum). It also eats the fruit of the tomato and strawberry, and bores into the cob of ears of corn as well as the stalk.

Its Depredations.

Among the records of its most serious injuries are the following: In 1868, a potato field at Lacon, Ill., was observed to have about every tenth stem occupied by this borer.*

In 1869, at Fox Creek, Mo., it was discovered boring into and ruining great numbers of peach "buds" and shoots.†

In 1869 it was reported from Farmington, Conn., as doing great damage to corn in that vicinity.‡

It 1871 it occurred within the straw of nearly all the wheat fields in Wisconsin. A piece of two acres of early wheat near Madison was entirely ruined by it.§

In 1877, at Elmira, Ill., fifteen acres of corn were destroyed by its depredations. At Waterman, Illinois, serious injury was done to many fields of corn. At Athens, Ill., it thinned the corn on new lands and in foul fields to a considerable extent, proving to be quite destructive.‖

In connection with the above notices of the depredations of this insect in Illinois, it is an interesting fact that the types of the American species of this genus described by Guenée — five in number — were specimens which had been collected in that State.

American Entomologist, i, p. 22. †Ib., p. 206. ‡Ib., p. 252.
§*Second Rept. Ins. Ill.*, p. 141. ‖*Seventh Rept. Ins. Ill.*, pp. 113, 221.

The Family of Noctuidæ.

The moth belongs to the *Noctuidæ*,* or owlet-moths as sometimes popularly called, from their habit of coming abroad from their hiding places after dark to feed: a few of them, however, fly by day. The family is quite an extensive one, and although it has been but recently studied in this country, over fourteen hundred species have already been described.† Their caterpillars are among the most obnoxious pests of the agriculturist, as for example, the many species of "cut-worms." The moths are stout-bodied, with strong-veined wings, enabling them to fly quite swiftly. With the exception of the Catocalas (beautiful underwings) and some of the allied genera, as a rule, they are so plain in appearance, as rarely to attract attention.

Description of the Moth and Caterpillar.

G. nitela is one of the very plain moths, being without any conspicuous markings. It is shown in Fig. 26 at 1. It measures about one inch and a half in expanse. Its wings are of a wood-brown color, sprinkled with yellowish dots. The only conspicuous ornamentation is a yellowish white line at the outer third of the front wings, bent at nearly a right-angle, near the front margin; between this line and the outer border the wing is paler.

FIG. 26.—The stalk-borer, GORTYNA NITELA *Guen.* The moth and its caterpillar. (Riley.)

The caterpillar, shown at 2, measures over one inch long when fully grown. It is purplish-brown above, with three white lines on the back, of which the central one is continuous, and the other two interrupted from the fourth to the seventh segments inclusive. The first two segments have a white stripe on their sides, and above the third and fourth fleshy legs (prolegs) there is another white stripe. The head and a corneous plate on the top of the first and last segments are shining yellow, bordered on the sides with black. In its walking, which is quite rapid, the caterpillar arches its back somewhat like the *Geometridæ* (measuring worms), as it does not use its first pair of prolegs.

In the *Harris Entomological Correspondence* (*loc. cit.*), a detailed description of this caterpillar is given. It is described under date of July 8th, 1848, as a caterpillar on potato-stalks — not referred to any

*NOCTUÆ *Linn.* (of Grote); NOCTUELITÆ *Latr.* (of Packard); NOCTUELITES (of Guenée); NOCTUIDÆ Stephens.

†The New Check-List of North American Moths [north of Mexico], by A. R. Grote, contains 1420 species of "Noctuæ."

species, as it was unknown to the writer; but it evidently pertains to this insect. The description is as follows:—

With ten prolegs and six true legs, a corneous plate on first and last segments; four black, shining points, two and two, on the back of each segment; a lateral row of much larger ones on the sides (of which there are three on the side of each segment, one large and two small, besides the black spiracle making a fourth black point), and also below the lateral line two more black points on each side of every segment, those on the segments furnished with prolegs, being on the sides of the prolegs themselves. Length nine-tenths of an inch. Elongated, slender, pale purplish-brown above, with three dorsal white lines, the central one continuous, the others interrupted on the middle of the back, from the fourth to the seventh segments inclusive (these three lines begin on the second segment.) On the sides of the first and second segments there is an abbreviated white stripe and above the third and fourth prolegs another white stripe. Head, dorsal and anal plates wax-yellow and shining, edged laterally with shining black. Legs black. Prolegs and body beneath pale yellow. The head of this caterpillar is large, subquadrate, not retractile. The legs and prolegs long, and the motion very active. The livid brownish color of the intermediate segments extends more or less in different specimens under the body of these same segments. Motion somewhat like that of a Geometrid, the back arched, and the first pair of prolegs, though as long as the others, not used in creeping.

Found one also in pigweed-stalk, July 5, 1851.

Natural History of the Species.

The history of the species so far as known, is this. The egg has not been observed. It is doubtless deposited by the moth during the early part of June, in our latitude, on the stem of the food-plant, near the ground. As soon as it hatches, the larva eats into the stem to its pith or heart, and burrows in an upward direction. The hole through which it entered and the lower portion of its burrow is enlarged from time to time, with the growth of the larva, to admit of the rejection of its excrement. If the stem should not afford it a sufficient amount of food for the completion of its growth, it eats a hole outwardly for its release, or escapes through the original opening, and passes to another stem within which it burrows. It attains its growth about the middle of August, when it changes to a pupa, either within its burrow, if affording it suitable conditions, or by deserting it, and entering the ground to a slight depth. The pupation is a short one, and the perfect insect makes its appearance during the latter part of August or in September. My earliest date of the collection of the species is September 5th. It is believed to survive the winter in the winged state and to reappear in the spring, to deposit its eggs on the young plants.

This species seems to be a rare one in the vicinity of Albany. Among the scores of thousands of the Noctuids which during the last few years have been collected by the Albany entomologists, by the *sugaring* method (attracting the moths to a bait spread upon trees), I have no knowledge of the occurrence of a single example of the species.

Allied Species.

A closely allied species is recognized in our lists, *Gortyra nebris* of Guenée, differing mainly in the presence of white reniform, orbicular, and claviform spots on the front wings, and in slightly longer and more ascending palpi. Prof. Riley has reared *G. nebris* from the horse-weed, *Ambrosia trifida* L., and expresses a confidence that the two forms (?) intergrade, and are simply varieties of one species. I have no knowledge of any description of the larva of *G. nebris*. Prof. French states that it differs from that of *G. nitela*, in that it pupates in the ground. About twenty-five species of North America *Gortyna* are at present known.* Of these, the larvæ of the greater number, from their concealed habits, are unknown. The larval habits of the species are not uniform, for while those which Guenée includes in the genus *Hydræcia*, are represented by him as "not living inclosed in stems and feeding on the pith, as those of *Gortyna*, but only concealed among the roots or the basal leaves of the plants" (of which are *nictitans* Linn., *immanis* Guen., and *stramentosa* Guen.), others in addition to *G. nitela* are known to be stalk-borers, as *G. rutila* Guen., in the Columbine, *G. cataphracta* Grote, in thistle-stems, and *G. flavago* W.-V., of Europe, in thistle-stems and burdock. It is not a little remarkable, that of the old Linnæan species, *G. nictitans*, so very common both in Europe and the United States, the larva has not, so far as we have any record, been identified in this country. Our ignorance of the larva of the common *G. sera* Gr.-Rob., is scarcely less remarkable.†

Remedies.

When this insect occurs in the potato, its presence can be readily detected by the withered stems before they have become broken down. By placing the point of a penknife in the opening and slitting the burrow upward, the caterpillar may be found and killed. If the field be large and too badly infested to permit the employment of this method, then, if the vines can be collected and burned before the month of September, all the larvæ or the pupæ which may be undergoing their change within the stems will be destroyed. As early potatoes are more liable to be infested by this borer than the later ones, the burning method may be easily resorted to. The same method of treat-

*The genus, for some reason, is a very unfortunate one in regard to its definition. It appears to have been closely studied by Mr. Grote, but no two of his several publications upon it agree in the species which it should embrace. In his latest publication, the New Check List, several of the long recognized Gortynas, such as *purpuripennis*, *sera*, *nictitans*, *stramentosa*, etc., are withdrawn from the genus and placed under *Apamea* of Treitschke.

†For comparative remarks on several of our Gortynas, which will prove of service to the student in the separation of species, the paper by Mr. Grote "On North American Moths," in the *Bulletin of the U. S. Geological and Geographical Survey*, vol. vi, 1881, at pp. 268, 269, may be consulted.

ment will be available for the destruction of the caterpillar in several other of the food-plants which it infests.

Heliothis armiger Hübn.*

The Corn-worm.

(Ord. LEPIDOPTERA: Fam. NOCTUIDÆ.)

HÜBNER: "Eur. Schmett., Noct. p. 370."

GUENÉE: Sp. Gén. Lép., vi.— Noct., ii, 1852, p. 181 (references and localities).

GROTE: in Proc. Ent. Soc. Phila., 1862, i, p. 219 (as *H. umbrosus*): in Bull. Buff. Soc. N. S., i, 1873, p. 122 (distribution).

GLOVER: in Rept. Commis. Agricul. for 1865, p. 43 (destruction by crows); Id. for 1866, p. 30 (inj.); Id. for 1870, p. 84 (food-plants); Id. for 1871, p. 84: MS. Notes Journ.— Cotton., 1878, plates 17, 18 (operations on cotton and different stages); in Rept. Commis. Pat. for 1854, pp. 64, 65, 69, 71, plates 3, 4; Id. for 1855, pp. 282–285 (habits, descriptions, and remedies); the same republished in Monthly Rept. Dept. Agricul. for July, 1866, pp. 282–285, with figures.

WLSH.–RIL.: in Amer. Entomol., i, 1869, pp. 212–214, figs. 150, 151 (habits, history, food-plants, etc.); Id., ii, 1869, pp. 42–44, f. 29 (food-plants, injuries, remedies).

TREAT: in Vineland [N. J.] Weekly, of Aug. 21, 1869 (injuries to corn).

RILEY: in Amer. Entomol., ii, 1870, p. 172 (tomato as a food-plant), p. 329 (associated species); 3d Rept. Ins. Mo., 1871, pp. 104–109, figs. 42, 43 (distribution, habits, description, remedies, etc.); 4th Rept. do., 1872, p. 129 (parasite); in Rept. Commis. Agricul. for 1881–1882, pp. 145–149, pl. 1, and pl. 12, f. 1.

LINTNER: in 30th Rept. N. Y. St. Mus. Nat. Hist., 1878, pp. 165, 166; Entomolog. Contrib., iv, 1878, pp. 52, 53 (carnivorous habits in Patagonia); in Count. Gent., lxvi, 1881, p. 759 (occurrence in N. Y., etc.); in Ontario County Times, Nov. 9, 1881 (history, habits, etc.).

THOMAS: 7th Rept. Ins. Ill., 1878, p. 4 (in Illinois); in Count. Gent., lxvi, 1881, p. 583 (description, habits, etc.).

FRENCH: in Thom. 7th Rept. Ins. Ill., 1878, pp. 102–106 (habits, description, remedies); pp. 231–233 (description); in 11th Rept. do., 1882, pp. 82–104.

COMSTOCK: in Rept. on Cotton Ins., 1879, pp. 287–315 (habits, description, history, remedies, etc.).

CLAYPOLE: in Amer. Entomol., iii, 1880, p. 278 (feeds on hard corn).

COQUILLET: in Thom. 10th Rept. Ins. Ill., 1881, p. 150 (figures and larval description).

MOFFAT: in Ann. Rept. Ent. Soc. Ontario for 1881, (1882), p. 30 (occurrence in Ontario).

KELLICOTT: in Bull. Buff. Soc. Nat. Sci., iv, 1882, p. 61 (occurrence in Michigan).

JOHNSON: in Rept. Commis. Agricul. for 1881 and 1882, 1882, pp. 150–152 (its history in Miss., enemies and remedies).

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*Originally named *armigera* but changed to *armiger* for conformity to the gender of the genus.

This well-known pest of the cotton and corn fields of the Southern States has, during the past year, made its appearance for the first time, as an injurious insect, in the State of New York. Examples of the caterpillars, nearly full-grown, eating into ears of corn beneath the husks, both at their tips and at their base, were first received by me from Ontario county, where their abundance and destructiveness were exciting considerable alarm. A communication from the editor of the *Ontario County Times* accompanying examples of the caterpillar for identification, stated: "It has attacked the growing corn when the corn is soft, entirely devouring patches of the kernels, and when the kernels harden, reducing them to a state resembling coarse meal." My reply to the request for information in relation to the depredator was published in the *Ontario County Times*, as above cited.

The "Boll-Worm" of the Southern States.

The caterpillar is the notorious "boll-worm" of the Cotton States, which annually commits such serious depredations upon the cotton crops, by burrowing into the bolls and destroying them. It is very common throughout the south, where it is present in every cotton field to a greater or less extent. In some years, over large districts of the south, the losses resulting from it have exceeded those of the "cotton-worm," *Aletia argillacea* Hübn.

The eggs of the moth, shown in Fig. 27 at *a* and *b*, which are very similar to those of the cotton-worm moth, and of which the female lays about 500, are placed, according to the latest and most reliable observations, not generally upon the involucre of the blossom, as represented by Mr. Glover, but upon the leaves, on both surfaces, oftener upon the lower. The newly hatched caterpillars from these eggs feed at first upon the leaves, but only for a short time, when they migrate to the flower-buds or bolls. Entering a bud through a round hole eaten therein, they feed upon the interior, destroying the organs, and causing the bud to fall. In this manner a single caterpillar may destroy a large number of buds. Later, the bolls are similarly entered, and their entire interior eaten away, or spoiled through the entrance of rain causing decay.

There are probably five annual broods of this insect in the Southern States, of which the last two, appearing in August and September, are the most injurious to cotton. The eggs of the first three broods are usually laid upon corn.

From observations made in Alabama, it appears that the eggs of the first brood are laid in early May; of the second brood, during the first half of June, and of the third brood, about the 1st of July; of the fourth brood, upon the cotton bolls by the 1st of August, and of the fifth brood, early in September.

Description of the Caterpillar and Moth.

The caterpillar is thick-bodied and almost cylindrical, tapering but slightly toward the head. When full-grown it measures almost one inch and a quarter in length. It varies in color, in different individuals, from pale green to dark brown, striped in darker shades of the same colors. The dark caterpillars have on each side a distinct, rather narrow yellowish stripe, upon which is the row of oval breathing-pores (spiracles). There are several black, shining, elevated spots or tubercles on each segment, each of which bears a short brown hair. One of these spots is placed just behind the spiracle, making two conspicuous spots on the yellow lateral band of the more central segments (at least, those bearing the four pairs of prolegs). This characteristic feature, appearing like a pair of spiracles, is shown in nearly all the illustrations which have been given of the caterpillar.

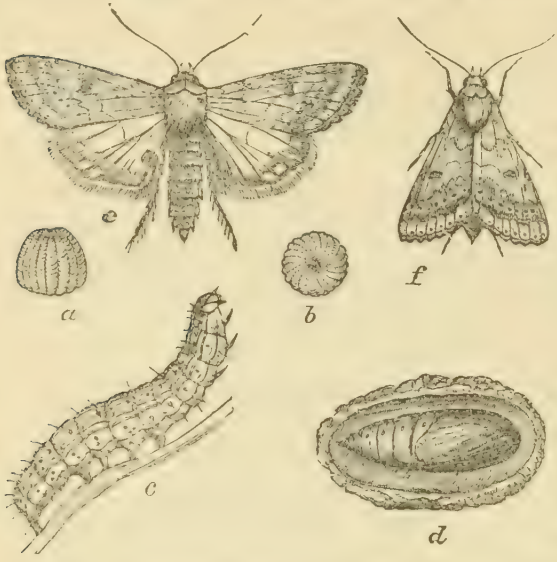

FIG. 27.— HELIOTHIS ARMIGER.—The corn-worm; *a*, *b*, the eggs; *c*, the caterpillar; *d*, the pupa within its cocoon; *e*, the moth; *f*, moth at rest (Riley).

The average expanse of the moth is about one inch and a half. It varies greatly in color, from a yellowish-gray to a clayey-yellow, often tinged with olive-green. The most distinctly marked examples have two often interrupted, brown bands crossing the fore-wings, and a broader and better defined one near to, and parallel with, the outer margin, upon which is a line of black dots upon a whitish spot, placed on the nervules. A black border defines the discal spot, which is often crescentiform. The hind-wings are of a paler shade, and have a broad blackish outer band, which toward the apical portion incloses a pale spot resting on the margin and throwing the black bordering inward toward the center of the wing. Beneath, the band and the discal spot of the upper surface are quite conspicuous.

The Moth a Day-Feeder.

Mr. J. A. Moffat, of Hamilton, Ontario, records (*loc. cit.*) its feeding in the day time on the flowers of the golden-rod (*Solidago*), and in the gardens of that place. He states of it: "A night-flyer properly, or in the dark of the evening, it seemed to have been tempted from its hid-

ing place by that peculiar dull, smoky weather of the first three weeks of September, when even the *Sphingidæ* forgot their usual caution and came forth boldly to feed at mid-day, having taken a tomato sphinx (*M. quinquemaculata*) at 2 o'clock in the afternoon of the 14th, feeding on petunias, whilst the white-lined sphinx (*Deilephila lineata*) could be seen by the half-dozen among the flowers at any time of the day. The Heliothis moth, being about an inch and three-quarters in expanse of wing, was quite a conspicuous object while feeding, more especially as it seldom rested, but kept its wings moving the while."

That its visit to flowers during the day time is not an unusual occurrence, appears from an observation made by Mr. C. G. Barrett, of Pembroke, Eng., who states: "While working the clover fields, I discovered the (to me) novel fact that *Heliothis armiger* flies most actively in the sunshine, feeding at the clover blossoms exactly like the swarms of *Plusia gamma* around it, and that it soon becomes in this way miserably worn." (*Ent. Month. Mag.*, xiv, p. 151.) Nor is the flight by day incidentally noted of *Deilephila lineata* at all uncommon. Prof. H. W. Parker records it, in August of 1880, as the most conspicuously common moth in the vicinity of Grinnell, Iowa: "*At all hours of the day* one or more might be seen hovering over nearly every flower of the innumerable weeds, mostly thistles and *Helianthus*, by the roadsides. In places, the moths might be estimated by the handreds" (*Psyche*, iii, 1882, p. 342).

Carnivorous Habits of the Caterpillar.

An interesting account of the carnivorous habits of the caterpillar is given by Professor Berg, Director of the Museum of Natural History of Buenos Ayres, as it came under his observation during some collections of Lepidoptera made by him, in Patagonia, in 1874.* The species occurred only upon those portions of the coast to which cultivation had extended, from which it seemed probable that it had been introduced through commercial intercourse with other countries. Large numbers of lepidopterous larvæ were collected and their transformations and food-plants observed. He writes as follows of a remarkable peculiarity in their habits:—

"It still remains for me to note a peculiarity of the caterpillars, viz., their extreme ferocity — their cannibalistic propensities. All of them, irrespective of family or group, manifest the liveliest desire to kill their fellows. While confined, they ate one another, seldom, if ever, touching the food-plants. The caterpillars of the *Bombycida* completely devoured others of the same family, leaving absolutely no fragments of them. They even tore open the cocoons, from which they dragged out the pupæ and ate them. In like manner, the larvæ of the *Noctuida* acted among themselves and toward the *Bombycidæ*, and the latter

*Bulletin de la Société Impériale des Naturalistes de Moscou, xlix, 1875, Partie ii, p. 192.

toward the former. Among these last, *Heliothis armiger was gluttonous beyond all measure* — one of them devouring in twenty-four hours from six to seven others. They *would not touch the plants after having once tasted flesh.*"

Professor Comstock records its carnivorous habits.* He states that when several larvæ were mailed to the Agricultural Department in the same box, only one would arrive alive, the others having been destroyed, even when the box contained cotton leaves and bolls, or corn leaves, in fresh condition. When rearing the larvæ in breeding-cages, although supplied with an abundance of fresh food, they seemed as hungry as ever for their companions, and eagerly devoured one another: it was impossible to rear them otherwise than singly in a cage.

Mr. Trelease reports (*loc. cit. sup.*) that he repeatedly saw large boll-worms catch small ones and either devour them entirely, or bite into them and suck their juices, rejecting the empty skin. In many instances he discovered boll-worms occupying the webbed-up leaves which the Aletia cotton-worms had prepared for their pupation, for the purpose of feeding upon the pupæ. Remains of pupæ were found which had been fed upon by the larvæ.

A gentleman from Mississippi states that he has seen in that State the Heliothis caterpillar eating the pupæ of *Aletia.*†

Judge Johnson, of Holly Springs, Miss., reports that the caterpillars of this species are the most ravenous and cannibalistic of vegetable feeding larvæ. They manifest a decided preference for the pupæ of other Lepidoptera. The large caterpillars would leave everything for the Aletia pupæ when they were to be found in abundance.‡

Professor French has found dead Heliothis larvæ in their burrows beneath the husks of corn, under conditions that convinced him that they had been bitten and killed by their associates in the ear.§

The Food-plants of the Caterpillar.

An unusually large number of food-plants have been recorded upon which the larva is known to feed, in addition to the two which it prefers, viz., cotton and corn. It has shown itself as a destructive tomato-worm, boring into both the fruit and the stem; it eats into the pods of peas and different kinds of garden beans, as string-beans and Lima beans; it burrows into pumpkins, squashes, and peppers, and in the stems of gladiolus. Mr. Trelease has found it feeding abundantly upon the cow-pea of the Southern States, boring from the outside into one chamber after another to eat the contents. It is recorded in Europe upon the chick-pea (*Cicia arietinum*), where also, according to M. Gourcau, it feeds upon heads of hemp, leaves of tobacco, and

Report upon Cotton Insects, 1879, p. 503.
†*Amer. Entomol.*, iii, 1880, p. 253.
‡*Rept. Commis. Agricul.* for 1881 and 1882, pp. 150, 151.
§Thomas' 11*th Report Ins. Ill.*, 1882, p. 92.

of lucerne (*Medicago sativa*). Another writer gives henbane (*Hyoscyamus niger*) as one of its European food-plants.

Geographical Distribution of the Species.

Few of our moths have so extensive a distribution as this, occurring as it does, in the four quarters of the globe. It is found in Great Britain,* France and elsewhere in Western Europe, but not abundantly; in Turkey, more commonly.†

It has been captured in the Cape de Verde Islands, and on the west coast of Africa (N. Lat., 23°.) ‡Guenée cites it from "Europe méridionale, Amérique du Nord et du Sud, Indes orientales, et Nouvelle-Hollande." It was found by Professor Berg in Patagonia, as before noticed, and examples have also been brought from Japan. According to Mr Moffat (*loc. cit.*), it was observed for the first time in the Province of Ontario during the past year (1881). It is not stated that the caterpillar was discovered, but the moth was "quite plenty" at Hamilton during the early part of September. Its unusual occurrence in the State of New York will be noticed hereafter.

Its Operations as a "Corn-Worm."

The caterpillar is known as the "corn-worm" throughout the South when it occurs on corn, as it often does in immense numbers, to the serious injury of the crop. Other names sometimes applied to it, are the "ear-worm," the "tassel-worm," and the "terminal bud worm." As the caterpillars of the species show a great range of variation in markings and color — some being green and faintly striped, and others brown with dark stripes — the "corn-worm" was for a long time, and is still by the uninformed, believed to be distinct from the "boll-worm;" but during late years, when they came to be studied, it was discovered that the two were the same species, and that it occurred on a number of greatly differing food-plants as above noticed.

The injuries committed by this species have, in certain seasons — usually such as are very warm and dry — been enormous. In Kentucky, entire fields of corn have been ruined by it. In 1860, in Kansas, during a protracted drought, the corn crop throughout the State was nearly destroyed. In a single county, which perhaps was not an exceptional one, the product was cut down from 436,000 bushels, the preceding year, to 5,000 bushels.§ In Southern Illinois, it has been very

*Its occurrence in England is usually deemed worthy of record. Thus we find the following: "On September 24, 1881, I took *Heliothis armiger* resting on a flower in the Rectory garden at Guestling.—E. N. B."—(*Entomol. Month. Mag.*, xviii, 1881, p. 141.) "On the 20th of June, I captured flying in a clover field in the bright sunshine, a fine *Heliothis armiger*, female.—A. H. J."—(*Id.*, xvi, 1879, p. 99.) Mentioned among rare Lepidoptera captured near Dartmouth, Eng., during 1874–1877, by Mr. G. F. Mathew.—(*Id.*, xiv, 1877, p. 157.)

†*Ent. Month. Mag.*, xviii, 1881, pp. 12, 99. ‡*Ib.*, pp. 81, 258.

§*Prairie Farmer*, of Jan. 31, 1861.

destructive. Occasionally it has extended into the northern portions of that State, but only in comparatively moderate numbers.

At the meeting of the American Association for the Advancement of Science, held in Cincinnati, in August, 1881, Professor Cook, of the Michigan State Agricultural College, communicated the fact that it had attacked corn in Michigan, in 1880, for the first time. (*Canad. Ent.*, xiii, p. 215.)

Prof. D. S. Kellicott, of Buffalo, N. Y., reports it as abundant during the month of July, 1881, at Corunna, Michigan, where the early corn was considerably damaged. In one field observed, more than half the corn had been eaten into by it.

In reporting upon its operations in Illinois, in 1877, Professor French states: "It has not been so destructive during the past season as it is sometimes, but in one field of late corn I found nearly every ear eaten by them, there being from one to half a dozen worms to each ear."

Method of Attacking Corn.

It has not been ascertained when the first eggs are laid upon corn, in New York. If the parent is a native of the State, from having hibernated as a moth or a pupa, the eggs would be laid upon the leaves of the young corn during the month of June, and the young larvæ would feed upon the leaves, eating irregular holes into them. When about half grown, they would be in condition to attack the tender terminal leaves, which they would seriously injure or wholly destroy. But as this injury has not been noticed in this portion of the United States, it seems more probable that our corn-worms are the progeny of moths which have flown hither from the south — probably of the third southern brood, and which had reached our State sometime in July. To the south of New York, in Southern Pennsylvania and Ohio, there may have been an earlier generation, proceeding from the second southern brood. In this manner, through successive broods, the northern progress may be presumed to have been made.

The operations of the caterpillars in New Jersey, during the month of July (?), have been observed by Mrs. Mary Treat. She states as follows: "They ate into the staminate flowers of the corn before it tasseled out, commencing their depredations while the tassels were still enfolded in the leaves. I have examined considerable corn, and in some gardens this worm has done much damage." In a communication under date of Aug. 25, 1869 (*Amer. Entomol.*, ii, p. 43), Mrs. Treat writes: "The other day I passed through a large field of corn, where the depredations of this worm were visible on almost every stalk. They had done the work weeks before, eating through the leaves while they were folded around the staminate flowers, before the ears had begun to make their appearance. It is difficult to find an ear free from their depredations."

The caterpillars infesting the corn fields in New York during October and November are of a later brood than those noticed above, although an earlier one may have escaped observation. The eggs which produced them were probably laid upon the young ears of corn near their tips, where the young caterpillar would be in position to reach the silk as soon as it developed. Upon this they feed at first, and as their desire for food becomes more ardent, they penetrate to the young kernels and devour them. The appearance of an ear of corn eaten by the caterpillar is represented in Fig. 28. When the corn is in the milk, it seems to be most palatable to them. They then burrow into and through the ears, often confining themselves to their apical portion. When the portion near the base is eaten, as shown in the figure, the caterpillar has penetrated the husks through a round hole of a size barely large enough to admit the body, as seen in some examples received by me from Ontario county. Occasionally the ear has been irregularly burrowed throughout its entire length.* Mould often follows the attack, to the serious detriment of the corn; and other insects are attracted, and continue the work that the corn-worm had commenced.

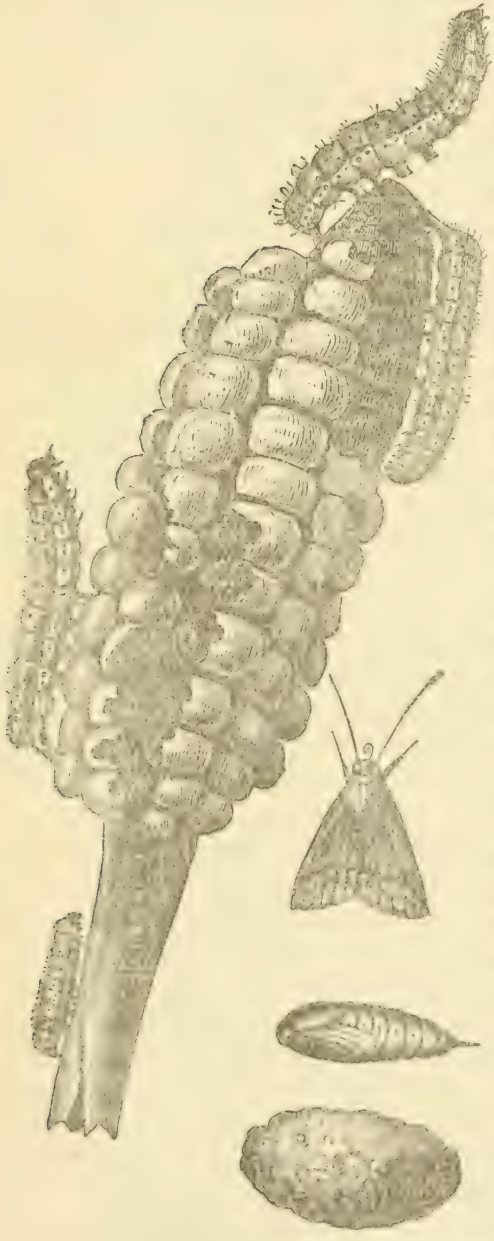

FIG. 28.—Corn eaten by the corn-worm; also the caterpillar at different stages of growth, the pupa, the cocoon of earth and silk, and the moth at rest (Riley).

Not only is the corn eaten while in the milk, but the nearly mature caterpillars are capable of continuing their feeding even after it has become quite hard, as shown by caterpillars which I have fed in confinement, and as recorded by Prof. Claypole (*loc. cit.*).

Forty-first Ann. Rept. N. Y. St. Agricul. Soc. for 1881 (1882), p. 153.

Its Occurrence in New York.

Subsequent to the announcement of the appearance of this insect at South Bristol, Ontario county, information was received by me of its injuries in other towns of the county, in Livingston county (*Country Gentleman* of Nov. 24th), and in Albany and Schoharie counties. It has probably been distributed over all of the southern and middle portions of the State. Happening to mention to a friend in Albany the interesting occurrence of this southern species in the State of New York, he recalled the fact that some green corn which had been purchased perhaps two weeks previously for his table was found unfit for use from the gnawing of caterpillars contained within the husks. Believing them to be identical with examples of the corn-worm which I was able to show him, he proposed to verify their identity. A severe frost had cut off the green corn in the vicinity of Albany, and comparatively few lots of surplus stock could be found at this date (Nov. 1st), at the vegetable stands and groceries, but in every one examined, the injuries were discovered in a large proportion of the ears: in some of them dead caterpillars were lying within the husks (with some still living), which had doubtless been killed by the frost. It could not be learned that this attack upon corn in the neighborhood of Albany had been previously noticed. It is strange that depredations so general and so extensive as were these, could exist and still fail to arrest attention.

The occurrence of this insect in injurious numbers in the State, for the first time, the past season, is undoubtedly the result of the unusually warm and dry summer and autumn months — conditions highly favorable to the increase of many of our insect pests, and to the extension northwardly of southern forms. It had been numbered among New York species, and examples of the moth have been taken by collectors, although very rarely, in the extreme southern part of the State — on Long Island and elsewhere, but I do not know of its having been seen abroad, so far north in the State as Albany.

There need be no apprehension that the species will continue its injuries to corn in our State. Experience elsewhere has shown that its northern extension is only exceptional, resulting from unusual conditions. Very many of the later caterpillars were killed by the early frosts, while those that had matured and entered the ground for pupation, will not, to any great extent, be able to withstand the severe cold of our northern winter. There may, therefore, be no survivors of the recent invaders, and whether they are to reappear the coming year in our corn-fields, may depend entirely upon the repetition of last summer's heat and drought, and the attendant flight hither of moths from the south.

Remedies.

Wherever this species occurs in large numbers, it seems to be practicable, by the use of the proper means employed in time, to prevent its becoming very destructive. As in other injurious species which have more than one annual brood, it is of the greatest importance that the remedial measures should be directed against the insect at its earliest appearance.

Hand-picking.— Experience has shown that the "corn-worm" may be controlled by collecting by hand the caterpillars of the first brood and destroying them. Even within the "cotton-belt," in Georgia, where it abounds, it has been found that when "the corn was carefully 'wormed' on two or three plantations, the boll-worms did not make their appearance that season on the cotton, notwithstanding that on neighboring plantations they committed great ravages." Their presence in the stalks can readily be detected by the holes eaten into the leaves; and later, when they have migrated to the ear, their hiding places are shown by the eaten and blackened silk mingled with their excrementa. If the husks of such ears be partly opened at the top, the worm may be found and destroyed.

Attracting by odor and drowning.— Another method which has given excellent results, where the insects occur abundantly, is to attract the moth when they are just from the pupa and before they have deposited their eggs, to a mixture of molasses and vinegar. The odor will draw them from quite a distance, and in their eagerness to feed upon the sweet substance, they are caught in it and drowned. As this method is equally serviceable for the capture of many of our injurious night-flying species, we quote the experience of Col. Sorsby, of Georgia, as given in the Patent Office Report (Agriculture), for the year 1855 (p. 285):—

"We procured eighteen common-sized dinner plates, into each of which we put half a gill of vinegar and molasses, previously prepared in the proportion of four parts of the former to one of the latter. These plates were set on small stakes or poles driven into the ground in the cotton field, one to about each three acres, and reaching a little above the cotton plant, with a six-inch square board tacked on the top to receive the plate. These arrangements were made in the evening soon after the flies had made their appearance; the next morning we found eighteen to thirty-five moths to each plate. The experiment was continued for five or six days, distributing the plates over the entire field; each day's success increasing [? decreasing], until the numbers were reduced to two or three moths to each plate, when it was abandoned as being no longer worthy of the trouble. The crop that year was very little injured by the boll-worm."

Attracting to light.— Another method of collecting the moths is to attract them to lamps so constructed that the insects flying to them shall fall into a reservoir arranged for the purpose, where they will be destroyed, as illustrated in Fig. 38 on page . Many styles of lamps have been devised which have been experimented with by the U. S. Entomological Commission in the cotton-fields of the South, and illustrated and explained in the Annual Reports of the Commission. The simplest form is that which is constructed as a torch, the oil reservoir being soldered to the center of a broad tin dish containing water with a small quantity of kerosene oil floating upon it, and fastened on the top of a stake thrust in the ground.

Benefit of Destroying the First Brood.

To illustrate the great importance of destroying the insects which would produce the first brood of a many brooded species, and the ease with which subsequent multiplication may at this time be prevented, we present the following calculation, showing the results which would follow the above experiments conducted *for a single night*, upon the supposition that each female of five successive broods* would have deposited its full quota of eggs, and that each egg would have produced a moth. It is scarcely necessary to add that not even a near approach to such an *entire* exemption from loss in the four distinct stages of insect life can ever occur in nature.

The average number of moths to a plate, as given above, being twenty-six, the entire number captured during the night would have been four hundred and sixty-eight. Assuming one-half of these to have been females, and each to contain five hundred eggs,† the caterpillars of the first brood would number one hundred and seventeen thousand. By the same method of calculation, we have for the second brood, twenty-nine and a quarter millions of caterpillars ; and continuing the computation until we reach the fifth and last brood, we have the amazing number of 457,031,250,000,000 caterpillars, or exceeding four hundred and fifty-seven trillions.

To present this computation in a more convenient and comprehensible form, — under the above conditions and by the same progressive increase, a corn-moth emerging from its pupa in May would be represented by a progeny of nearly two trillions of caterpillars (1,953,125,000,000) in its last annual brood in November, — a number fourteen hundred times greater than that of the entire human population (as estimated) of the globe.

*In all but the extreme southern portion of the cotton-belt, there are, normally, five annual broods — the last appearing early in September. In exceptionally fine seasons, it is probable that there is also a sixth brood. (*Rept. Commis. Agricul.*, for the year 1879, p. 342.)

†A boll-worm moth, dissected by Dr. Jno. Gamble, contained upwards of five hundred eggs (Glover — *Rept. Commis. Pat.* (*Agricul.*), for 1855, p. 282).

Crambus vulgivagellus Clemens.

The Vagabond Crambus.

Order LEPIDOPTERA; Family PYRALIDÆ.

CLEMENS: in Proc. Acad. Nat. Sci. Phila., 1860, p. 203 (original description).

ZELLER: Beitr. Kennt. nordamer. Nachtf., i, 1872, p. 93 (539), (comparative observations, as *C. chalybirostris*).

GROTE: in Canad. Entomol., xii, 1880, p. 17 (Vancouver locality); Ib., p. 79, (list of Crambus species).

LINTNER: in Alb. Eve. Journ., of May 23, 1881* (ravages of "army-worm"); Ib., of July 1 (Crambus species and *N. violans*); Ib., of Sept. 8 (cocoons, imago, and predictions); Courier and Freeman [Potsdam, N. Y.], of May 26 (distribution, alarm, etc.); St. Lawrence Repub., of June 8 (ravages, habits, etc., with *N. violans*); Ib., of Sept. 14 (eggs and moths); Ib., of Sept. 28 (reprint from Ogs. Daily Journ., of Sept. 21); The Husbandman [Elmira, N. Y.], of Sept. 14 (ravages, habits, description, transformations, etc.); Ogdensburg [N. Y.] Daily Journ., of Sept. 21 (remedies proposed); Count. Gent. [Albany, N. Y.], of June 2, xlvi, p. 359 (from Alb. Eve. Journ., of May 23); Ib., of June 9 (identified as *N. violans*); Ib., of Sept. 29 (abundance, predictions, etc.).

——: in Cincinnati Commercial, of Aug. 20; Cin. Daily Gazette, of Aug: 20; Science [N. Y. city], of Oct. 1, ii, p. 467 (abstracts of paper at A. A. A. S.).

ADAMS: in Watertown [N. Y.] Daily Times, of Aug. 22 (history, etc.).

RILEY: in Amer. Nat., xv, p. 574 (associated with *N. violans*); Ib., p. 750; Ib., p. 914 (abundance, description, and eggs).

SAUNDERS: in Canad. Entomol., xiii, pp. 181–3, 199, 200; in Ann. Rept. Ent. Soc. Ontario, for 1881–1882, (1882), pp. 6, 13 (general notice).

RILEY: in Ann. Rept. Commis. Agricul. for 1881–1882, (1882), pp. 179–183 (injury, natural history, description, remedies, and bibliography).

The history herewith presented of the insect which suddenly appeared in such countless numbers in the pastures and meadows of Northern New York the past year (1881) is of such unusual interest, from the extent of its distribution, its serious ravages, the alarm excited by its advent, the probability of its recurrence, and also as affording an illustration of a phenomenon not unfrequently observed by entomologists — of the sudden multiplication of a hitherto harmless insect into formidable and destructive hosts — that no apology is required for presenting it in more than ordinary detail, or for the repetition of much that has been already published by me (see references above) in several newspapers and other journals.

First Notice of its Occurrence.

On the 18th of May last, letters were received by me from Potsdam, N. Y., and also by Mr. T. L. Harison, Secretary of the State Agricultural Society, announcing a formidable invasion of the grass-lands of several of the towns of St. Lawrence county by the army-worm.

*All the following citations (except the last two) are of the same year (1881).

The ravages had only been observed during the preceding ten days, but already had they increased to such magnitude that many extensive pastures had been completely ruined. The entire destruction of both the pastures and meadows was threatened, and serious detriment to the important dairy interests of the northern counties of the State was anticipated. My advice was asked as to the best means of arresting the ravages. I had never witnessed an army-worm invasion, fortunately of rare occurrence in the State of New York, and as the present one seemed to promise unusual interest from its northern locality and early period of the year, I left Albany on the evening of the reception of the above information, in company with Secretary Harison, that, after personal observation, I might return more satisfactory replies to the inquiries addressed to me.

Narrative of its Observation.

Inquiries made at Rouse's Point, Clinton Co.— the extreme northeasterly portion of the State — failed to elicit any information of an attack in that vicinity. Our route thence, *via* the Ogdensburg and Lake Champlain railroad, traversed, for the most part, the wild and uncultivated parts of Clinton and Franklin counties, where but little grass occurred to invite grass-feeding insects. Leaving the railroad at Madrid, St. Lawrence county, and proceeding southward, the appearance of a pasture two miles from the station, on the farm of Mr. Fay, gave indication of attack such as had been described to us. Upon examining several brown patches, it was found that the grass had been closely eaten off, and slowly traveling over the surface were a number of apparently sickly caterpillars, which were evidently the authors of the injury. In one low, wet spot, a large number of dead caterpillars were lying on the ground. Perhaps twenty-five could have been counted in an area of a square foot, which, from their condition, we believed to have been killed by the heavy rains of the three preceding days. In the entire absence of caterpillars feeding, it was questioned if the attack had been arrested by weather unfavorable to them, or had they been otherwise destroyed. A well-known "caterpillar-hunter" was present in unusual numbers, and had undoubtedly rendered good service in checking the depredations, for under one small stone turned up we found no less than five of the pretty Carabid beetle, *Calosoma calidum* (Fabr.) — a valued ally in our warfare against the hosts of injurious insects. That it may be recognized and protected whenever discovered (together with other species of the genus and family, nearly all of which have similar predaceous habits, and are very important agents in checking the

FIG. 20.— CALOSOMA CALIDUM, slightly enlarged, with further enlargement of antenna and maxillary palpus.

excessive increase of our insect enemies, and of which it may serve as a representative form), it is shown in the accompanying figure.

Observations at Morley.—In many of the pastures lying upon the road to Morley, patches, some of considerable extent, were seen where the grass had been destroyed, as we were told, during the past week. On entering Morley, a long stretch of a number of acres of pasture land sloping down to the west bank of Grass river was pointed out to us as an infested district. No shade of green could be seen upon it, and it looked, at the distance, like a barren, sandy surface. Upon reaching the residence of Secretary Harison, the unwelcome intelligence was communicated to him that the "worm" had made its appearance in his pastures. An examination of them showed their depredations, not extensive, but quite unmistakable, on many of the little knolls where most of the grass had been eaten off nearly to the crown, leaving only the dead and bleached blades of last year's growth. A few caterpillars were discovered here, by turning over stones and pieces of decayed wood, but none were seen feeding or in travel.

The farms of Mr. Lorenzo Fenton and Mr. John Rutheford were next visited, where the "worms" had been reported in force. Upon each of these, several acres of elevated pasture land were almost as brown as in mid-winter, or, if showing any living vegetation, it was only sorrel or some other wild growth. Two weeks previous the same fields were entirely green and already affording fair pasturage. It was a strange sight to see these desolated fields—some having only portions destroyed, but the browned areas daily enlarging—and almost an entire absence of the destroying agents. We were told that the caterpillars were in the ground, and that large numbers could be taken from every piece of sod lifted in a certain portion of the field. We examined the place, which was almost stripped of its grass, but only a few larvæ were found in the sod. The interesting discovery, however, was here made of the subterranean retreat of the caterpillar, at about a half-inch beneath the surface, within a tube closely investing its body, composed of fresh bits of green grass, closely compacted and fastened together by silken threads, which at first sight seemed to be excrementa, but on closer examination showed unaltered vegetable structure.* Passages from the surface of the ground seemed to lead to the cases, and it appeared to us that they might serve for the abode of the caterpillar during the day, which they would leave for feeding above ground at night. It was stated to us, but on rather doubtful authority, that the caterpillars had been observed feeding in the day-time, when cautiously ap-

*The correctness of this observation has been questioned, and the material of the case pronounced excrementa. Its true character can be determined beyond dispute another season.

proached, but as soon as alarmed they quickly withdrew beneath the surface.

Observations at Potsdam.— I next visited Potsdam, St. Lawrence county, where the "worm" was reported as very abundant, and as having been very destructive. The reports had not been at all exaggerated. Hundreds of acres of pasturage in the town of Potsdam had been destroyed, and not a single farm, it was believed, had escaped attack. Under the kind escort of Mr. E. Clarkson, I was able to examine the pastures and meadows upon several of the farms where the injuries had been the most severe. My observations upon the farm of Mr. L. Benson may serve to give an idea of the seriousness of these injuries, not much exceeding what was seen by me elsewhere. An upland pasture, containing fifty acres, which, ten days previous to my visit, had afforded good pasturage, was now entirely brown. No grass could be seen in glancing over its whole extent, except over a narrow strip which had been used as a roadway when farming purposes necessitated occasional passing from one field to another. This, from some unknown cause, had remained green.* Upon stooping down and carefully examining the surface, amongst the sorrel and other weeds which had not been eaten, an occasional blade of grass, overlooked by the caterpillars, could be discovered, averaging perhaps one blade to the square foot, so completely had the grass been destroyed. Hundreds of dead and dried, or nearly dead larvæ, attached to stems and stalks of weeds, or last year's grass, at a height of from six to twelve inches above the ground, could be seen at one glance of the eye, by placing the head near the ground and looking over the field. In all probability most of these were victims to starvation, and not to parasitism, as at first thought, for no parasites were subsequently obtained from a large collection made of them.

A meadow belonging to Mr. Benson, adjoining the above pasture, and bearing a fine growth of grass, was seen to present a few spots having a suspicious appearance. One of these was examined, and in a small piece of sod six inches square cut by a spade, about twenty of the caterpillars were found, several of which (perhaps all, previous to their disturbance by tearing the sod apart) were contained in the green tubular cases previously mentioned. As a test of the distribution of the caterpillars throughout the meadow, pieces of sod were taken up at random in several places, by walking two or three rods with closed eyes and then inserting the spade in the ground. In each instance, larvæ were discovered. In view of this discovery, not previously suspected, Mr. Benson proposed at once turning in his stock and feeding off the grass before it should meet with the destruction to which it

*Perhaps the larvæ had found the soil too much compacted from even the moderate amount of travel over it, to permit of its penetration for the construction of their subterranean galleries.

seemed doomed. I counseled a delay of a few days, until some experiments could be made of means which might perhaps prevent farther depredations. It was suggested that strips of about ten feet in width should be staked off in the meadow, and that some harmless substance (not daring to recommend poisonous ones on meadow land), which might render the grass unpalatable for food to the larvæ, be scattered over each strip. Upon one plaster might be used, upon the next lime, upon another ashes, on another salt, and on a fifth road-dust. These applications were to be made when the grass was wet with rain or dew, and renewed if washed away by the rain. The relative effect of the several applications was to be noticed, and if effectual in arresting the depredations, that which gave the best result should be employed at large.

Upon another farm, that of Mr. R. C. Green, I examined a side-hill pasture of several acres, of which about two acres had been destroyed. A line separating this portion from the uninjured part, running down the hill, was distinctly traceable, but no cause for its existence could be discovered, either in the character of the soil or conformation of the ground. Perhaps it marked but a temporary limit, which may have shown an advance the following day. Another field below, on quite low ground, was so entirely browned that I could not convince those with me that it had not been winter-killed, until by stooping down and parting the dead grass of the preceding year, I was able to point out a thick growth of new grass closely eaten to the surface of the ground.

Characteristics of the Attack.

Several interesting features characterized this attack. It was in most instances observed first on upland and old pastures, — differing in this particular from the invasions of the northern army-worm, *Leucania unipuncta*, which ordinarily commences on low grass lands, working thence upward.

Its progress was remarkably rapid. A brown patch first observed in a pasture would rapidly extend its area, and often embrace the entire field in from ten to twelve days. Whether this was the result of the spreading of the larvæ from certain points where the eggs had been deposited, or the unequal hatching of the eggs distributed over entire fields, as influenced by various conditions of warmth, moisture, etc., I could not ascertain, for the brief time which I was able to devote to my observations did not permit of the detection of the eggs or their empty shells.

The secrecy with which the depredations were conducted was unusual and surprising. The extension of the infested areas could be observed from day to day, seemingly as causeless as a blight. Only a few

persons had seen the larvæ, and fewer still had witnessed their feeding. They were, for the above reasons, believed to be nocturnal feeders. An informant, who had observed the movement of a blade of grass, which, retaining its attachment to the root, had its tip bent downward and carried into a hole in the ground, inclined to the belief that most of the feeding, and all of that done during the day, was subterraneous, the larva gradually drawing the blade in its concealed retreat as it fed upon it. Objections to this theory were found in that the grass was usually eaten closely down to the crown of the root, and that holes in the soil which should lead to such retreats were very rarely seen.

Local Gatherings of Caterpillars.

No migration, like the hunger-impelled marches of the army-worm had been seen, or any common progressive movement of the caterpillars. In two instances, as narrated to me, immense numbers were observed in assemblages so large as to give countenance to the prevalent idea of an army-worm invasion. In both cases they had collected about the base and upon the trunk of a tree (a maple and an oak), to the height of two or three feet above the ground. They not only entirely covered the surface, but were piled upon one another so that, as stated, they could have been scooped up by handfuls. This occurred at Potsdam, three days previous to my visit to the place. That I might, if possible, verify these statements, I visited one of the localities of these gatherings, on the farm of Mr. L. D. Partridge, upon an island in the Raquette river. The caterpillars had evidently been here in force, for all the grass upon the island had been eaten. The oak tree which had been mentioned as the gathering point was readily found, as it was the only oak in the field. It was evident that their number had not been misrepresented, for the trunk was found enveloped to a height of eighteen inches, with a firm web of silk which had been spun by the hosts of larvæ, as was also a decayed stump of about two feet in height, standing a few inches from the tree. Upon the upper surface of a prostrate log adjacent, and extending thence a short distance over the ground in the direction of the tree was a similar web, and some large stones lying at the base of the tree were also coated in the same manner. The web, especially that upon the tree, was of so firm a texture that it could be stripped from the bark in a continuous sheet like a piece of woven silk. There were no excrementa mingled with it. Throughout the sheet were little openings of various sizes, averaging perhaps one-fourth of an inch, for which I was unable to account. They could not have been places of egress, for the construction of the web clearly did not permit of such immense numbers of caterpillars as were necessary to its formation, to have been massed beneath it.

A few stragglers of this host had been left behind and were aimlessly, it appeared, traveling slowly over the web. They were secured and, on comparison, were ascertained to be identical with those which I had elsewhere observed. The object of the assemblage at this particular point can only be conjectured. It was not for feeding, for the closest scrutiny failed to give evidence that the larvæ had ascended the tree even to the height of the lower branches. It is possible that there may have been a migration at this time and place from the desolated pasture, and the shade of this, the only large tree in the vicinity, may have been sought as an agreeable refuge from the hot sun suddenly appearing after one of the "April showers" which characterized this portion of the month of May.

Alarm Excited by the Attack.

As previously stated, the insect — the abundance and the ravages of which have been recounted — was generally accepted, throughout the district invaded, as the "army-worm." The local papers contained notices of its appearance at different points, and gave statements of the number of acres of grass already destroyed on several farms. The *Courier and Freeman*, of Potsdam, of May 26th, in an extended notice which it gives, states: "So far as we have heard, farmers are making no general effort to check the pest. An occasional furrow is turned or a piece of land rolled, but no combined and effective work is being done." The editor records sales of cattle that had been made in the vicinity, during the week, of ninety-four head, at low prices quoted, in anticipation of the entire destruction of grass in both pastures and meadows. Long extracts were made from the writings of Dr. Fitch and Prof. Riley, of the appearance and habits of the army-worm with methods for fighting it, so that it might be properly met when the existing demonstration should have developed into those migratory armies of which such graphic accounts have been given. Throughout St. Lawrence county, where the ravages had been the most serious, general consternation prevailed, not confined to agriculturists, for there was well-founded apprehension that every lawn and grass-plot would be invaded. It became the common topic of village conversation. At a meeting of the Ogdensburg Board of Trade, on the 23d of May, resolutions were passed, requesting from the State Entomologist such information and recommendations as might be of service to the farmers and the public generally. The Secretary wrote at this time: "Hundreds of acres in the towns of Oswegatchie, Lisbon and Morristown are completely ruined. If an army of Rebels or Fenians had invaded our frontier, the people could not have been more excited than just now over the ravages of this pest. Time can only tell what dam-

age St. Lawrence county may be obliged to sustain on its account. Acres of pasture can be seen without a spear of grass upon them."

Description of the Caterpillar.

The caterpillars which I collected in the towns of Morley and Potsdam, and which I saw at those places slowly traveling over the herbage, lying dead upon the ground, attached to spears of dead grasses, or taken from their retreats among the roots of the grass, were, beyond doubt, the authors of the above-noticed ravages, although at no time detected in the work. Their appearance is shown in Fig. 30, and may be described as follows: They were of a slender, cylindrical form with the normal number of legs — sixteen. Their color was usually sordid or obscure greenish, with a shining black head of rather more than one-half the diameter of the body, and the upper part of the following segment, brown. Their markings were in spots, and not in lines. On the upper side of the principal segments (differing always on the front ones) there were four glassy, slightly elevated, brown spots, each bearing a black hair of about the length of one-third the diameter of the body; of these the anterior pair of each segment are broadly oval and two-dotted, the outer dot having the hair, and the posterior pair elongate-elliptical with the hair upon its outer portion. On the side of the body, immediately over the small black spiracle or breathing-pore is a subtriangular brown spot (also bearing a hair), an arm from which extends downward behind the spiracle, partly surrounding it. Beneath the spiracle is a less conspicuous, elongate-oval, brown spot, in which are two short hairs. Below and somewhat back of these is an oblique-oval, brown spot with a long hair. Still downward and directly over the base of the prolegs is an obscure crescentiform spot, in which some black points (four or more), bear minute, blackish hairs. The joints of the thoracic legs are marked with brown outwardly, and the plantæ of the prolegs (the small prehensile hooks encircling their tips) are blackish.* The average length of the larvæ was about three-fourths of an inch. It was subsequently found that they had at this time about attained maturity.

FIG. 30. — Caterpillar of the Vagabond Crambus — CRAMBUS VULGIVAGELLUS — twice the natural size.

The Species not Determined at the Time.

I was unable, at the time of my visit, to determine whether or not the depredator was that of *Leucania unipuncta*. If that species, it

*The details of this description and the figure are from alcoholic examples.

differed greatly from its appearance at maturity, in not showing the characteristic stripes and in other particulars. But I had never seen the latter in its immature stages, — the published descriptions were not sufficiently full to remove all doubt, — and from the small size of the former, two moltings would be required in order to attain to the mature size of the army-worm, and even in a single molting very great change in appearance and form is often developed. The observed habits differed in important particulars from those ascribed to that species, and, above all, the time was nearly two months in advance of the proper season for its presence in Northern New York. Moreover, I could find no record of its occurrence in destructive numbers in that portion of our State, which lies outside of the limits of its serious ravages in the map given by Dr. Packard.*

Observed in Jefferson and Oswego Counties.

On my return from Potsdam, *via* the Rome, Watertown, and Ogdensburg railroad, the ravages of the caterpillars could be readily detected from the windows of the moving train at various places in St. Lawrence, Jefferson, and Oswego counties, by the brown patches, usually of small extent, on knolls and in the more elevated portions of the pastures bordering the road. Near Richville, several large infested patches were seen. None were noticed at Keen's Station. At about a mile south of Sanford's Corners, in Jefferson county, and continuing for some distance farther, traces of the attack were visible in small browned spots in the pastures. Within about two miles of Watertown, it became quite noticeable, and for a few miles beyond, several pastures showed the higher portions infested, and a grain field was also believed to be suffering from it. It was again noticed as we approached Adam's Center, and after leaving Sandy Creek, in Oswego county. South of this point, it was suspected in places, but I could not be positive of its presence.

Additional Collections of Larvæ at Potsdam.

A number of the larvæ which I had collected were placed in a box with sod, and brought home with me. They were objects of interest to many of my fellow passengers en route, as the hitherto unrecognized authors of the injuries with which they were familiar. The larvæ proved difficult to rear in confinement, and although as near an approach as was convenient to their natural condition was given them, most of them died within a few days; a few escaped. Two of their cocoons only were subsequently taken from the sod. One of the cater-

Ninth Ann. Rept. U. S. Geolog.-Geograph. Surv. Terr., for 1875 (1877), map 8.

pillars, after the death of the larger number, was removed and placed in a separate box, with some blades of grass for food. Here it shortly went into the pupal state within the grass, without forming a cocoon, and after sixteen days of pupation disclosed its imago, which proved to be *Crambus exsiccatus*.

In consideration of the poor success attending my attempts at rearing the larvæ, I wrote to a friend at Potsdam, requesting additional examples at their present more advanced stage. A large number were collected from beneath sticks, pieces of rails, leaves, stones, dried excrements, etc., and sent to me. They presented quite a different appearance from the previous collections, but the difference was ascribed to additional moltings. They, however, proved to be a distinct species — one of the *Noctuidæ*, known as *Nephelodes violans*, the caterpillars of which had been named by Prof. Riley as the bronze-colored cut-worm.

Cessation of the Ravages.

My visit to St. Lawrence county must have been at about the time of the greatest depredations of the caterpillars, perhaps a little later for from that time they seemed to diminish: by the 25th of May they were nearly completed, and by the end of the month it is thought that they had entirely ceased. Reports published in the *St. Lawrence Republican* from several of the county towns, under date of June 6th and 7th, mention their disappearance, and that the pastures which had been eaten off were beginning to look green again — a gratifying evidence that the roots had not been injured.

Abundance of Cocoons, at Watertown, N. Y.

On the 1st of July, a communication was received from Mr. J. Q. Adams, of Watertown, N. Y., accompanied by material which gave the first clue to the identification of this destructive pest. It undoubtedly belonged to the *Pyralidæ*. Its injuries had not been so serious in Jefferson county as in St. Lawrence, yet in a pasture near Watertown which had been infested by them, its cocoons occurred so numerously, that a half-dozen could be taken from a piece of sod of the size of one's hand. The cocoons were found with one end (the more loosely constructed one) at the surface of the ground, and the other perpendicularly beneath it among the roots of the grasses. A hundred or more of these cocoons were kindly sent to me by Mr. Adams. Those that I opened for examination confirmed the statement of Mr. Adams that the transformation to the pupal state had not yet taken place, although the cocoons had been formed at least a month before.

The caterpillars which they contained were identical with my Potsdam alcoholic examples, although notably of a paler color than were

those in nature — the result, doubtless, of their long exclusion from the light during their cocoonage. They gave no evidence of having been parasitized, but were, to all appearance, in a healthy condition, displaying, when disturbed in their retreats, a facility of locomotion fully equal to that manifested during their active stage of six weeks before.

The Cocoon.

The general appearance of the cocoon is represented in Fig. 31. It however varies considerably in size and form. The figure is taken from one of the largest size, while others are but half so large. The average of thirty examples gives a length of 0.9 inch, and a diameter at the broadest part of 0.24 inch. The shape is subcylindrical, but varying from an almost uniform diameter, to an enlargement of the lower portion to twice the diameter of the upper part. The interior consists of a closely spun sheet of silk, to which is connected the rather thin outer covering of earth, mixed with the finer rootlets of the grass. Nearly all the cocoons show curvature similar to that represented in the figure.

FIG. 31. Earth cocoon of CRAMBUS VULGIVAGELLUS, — natural size.

Delayed Pupation.

Early in July (precise date not noted), upon opening several of the cocoons for examination, the caterpillars were found within them still unchanged, although they had at this time been in this inactive state for a period of from one and a half to two months. The change to the pupa state in the Lepidoptera usually takes place within a week after the caterpillar has made its cocoon. The delayed pupation of this species is an interesting feature in its life-history. A similar prolongation of the larval stage is well known to those who are in the habit of rearing Lepidoptera, to pertain to at least several species of the *Ptilodontina* among the *Bombycidæ*, which pass the winter in this condition, pupating only a short time before the disclosure of the imago in the spring.* It has also been observed in some species of the *Noctuidæ* as in *Xylina antennata* Walker (*X. cinerea* Riley), in which the larva lies unchanged in its ear-horn cocoon from June to [illegible]

*I have observed this frequently in *Œdemasia concinna* (Sm.-Abb.) and in *Calodasys unicornis* (Sm.-Abb.). Dr. H. S. Jewett informs me that *Cerura borealis* [? *occidentalis*] makes cocoons late in summer and pupates the following spring; and *Heterocampa marina* (Packard), after making its cocoon just below the surface of the earth or of bits of leaves, twigs, etc., lies dormant through the winter, and pupates in the spring.

All the Notodontians (together with *Limacodes*) remain a long time in their cocoons, or in earth, before turning to pupæ (Harris, *Ent. Corr.*, p. 242).

ber, until within a few days of its appearance as a moth.* I had never known it to occur among the *Pyralidæ*, nor could any notice of its occurrence be found in a thorough search through the literature of the family, both European and American. Professor Riley, however, has informed me, that he had observed it in some species of *Botys*. That it was not a family characteristic, or that it does not necessarily control all the species of a numerous genus, appears in the fact above stated of the prompt transformation to the pupa and thence to the imago of *Crambus exsiccatus* — a species in which the larva so closely resembles those of which we are writing, that, when seen apart, it was believed to be the same.†

On the 8th of August ten of the cocoons were opened. Of these four were empty — the larvæ probably having deserted them in consequence of the disturbance attending their removal from the soil and their transportation to me, for, when received, several of the larvæ were wandering among the cocoons. The other six cocoons contained pupæ; and the pupation of all the rest at this time was accepted, in preference to sacrificing a larger number in further examination.

The Pupa.

The pupa, in each instance, was lying in the upper and loose end of the cocoon, in convenient position for its egress. Fig. 32 shows its general appearance, but gives too great a relative breadth across its wing-cases. In length it measures from 0.35 inch to 0.45 inch — average of six examples, 0.408 inch; average greatest diameter, 0.1 inch. Its color is pale brown. The females are ovoid in form, with the segments showing indistinctly; the males are cylindro-conical with well-defined and rounded segments. Head-case projected at the tip, and eye-cases prominent. Tips of wing-covers rounding over the segment, the inner wing-cover showing its margin over more than three segments. The stigmata appear as minute tubercles. Anal tip, dark brown, blunt and slightly excavated beneath.

FIG. 32.—Pupa of CRAMBUS VULGIVAGELLUS, enlarged.

The Species Determined.

On the 6th of August the first moth was disclosed from my Watertown cocoons. Professor Riley, at Washington, had obtained examples

*According to Mr. S. L. Elliot, of New York city, this species matures and enters the ground in June, where it remains as a larva until in October, when it pupates, and the moth is disclosed twenty days thereafter.

†In some of the other orders, there are interesting cases of delayed pupation. In the Diptera, *Diplosis tritici* and "all the numerous willow gallgnats belonging to the same genus [*Cecidomyia*], remain in the larva state without eating all through the winter, and until a few weeks of the time when the perfect midge is destined to appear, *i.e.*, with this particular species [*D. tritici*], until some time in May (Walsh, *Practical Entomologist*, ii, 1867, p. 99).

Among the Hymenoptera, *Cimbex Americana*, the largest of our saw-flies, occurring on the elm and willow, spins up in July and remains as a larva until the following spring. (Id., ib., p. 101.)

two days before, from cocoons which he had also received from Watertown. It proved to be the species known as *Crambus vulgivagellus* Clemens, identical with that, it is believed by our best authorities, subsequently described by Professor Zeller, as *Crambus chalybirostris*. The interesting and perplexing question of the preceding three months — to which of our insect depredators was chargeable the ravages in Northern New York, more serious in the extent of territory embraced than an army-worm invasion — was decided. The new enemy — the latest addition to our list of formidable insect pests — was found to be a modest, inconspicuous, and hitherto unobtrusive *Crambus*.

The species has been known to entomologists for many years. It has been rather a common insect, having had name and place in most of our collections. Nothing was known of its life-history, and it had never been recorded as in the slightest degree injurious. Now that it has so suddenly achieved notoriety, a popular name seems to be needed for it, for the use of those who would find it more convenient and agreeable than any of the class that they delight to stigmatize as "jaw-breaking Latin names." It is not always easy to select a common name which shall be both correct and distinctive, especially in a group where there are many species almost identical in appearance and habits. In view of this difficulty existing in the present instance, we have resorted, as has often been done, to a translation of the scientific name, and have designated the species as the *Vagabond Crambus*. If there is ever satisfaction in a resort to objurgatory epithets, this one may afford to the farmer, who contemplates its fearful ravages in his pastures, a measure of relief akin to that which might be experienced in a free translation of the scientific name of the wasp, *Vespa diabolica*, by one who had just experienced its venomous sting.

Family Characteristics.

To those who are not familiar with that division of the pyralid moths to which this species belongs — the *Crambidæ* — it may be of interest to state that they are small moths, usually less than an inch in spread of wings, and presenting in general the following features: The antennæ are thread-like; the palpi projecting like a beak for some distance in front of the head; body and legs long and slender; the front wings are narrow and long and are often ornamented with dots and lines in silver or gold; the hind wings are semicircular and plain, and in repose are folded like a fan under the front wings; both pairs, when the insect is at rest, are wrapped tightly around the body in cylindrical form. They frequent meadows and pastures during the latter part of summer, and when driven up by approaching footsteps, they fly for a short distance with a staccato flight, when they alight

and hide beneath a leaf or upon a blade of grass, head downward, where, from their manner of folding their wings about them, they almost escape observation. This attitude, at rest, is the explanation of the name "*Close-wings*," sometimes applied to them in England.

Sixty-four species of North American *Crambidæ* are catalogued by Mr. Grote, more than half of which belong to the genus *Crambus*. A common termination which usage has authorized for their specific names, is *ellus;* while in another division of the *Pyralidæ*, viz., *Phycidæ*, the termination of *ella* has been adopted, and in the remaining divisions, *Pyralididæ*, etc., *alis* (unfortunately shared by the Deltoides of the *Noctuidæ*).

Abundance of the Moths.

But few additional moths emerged from my cocoons prior to the 15th of August; from that time to the 25th by far the larger number were disclosed.

About the middle of August they were abundant in the localities where their caterpillars had swarmed in May. Under date of August 19th, Mr. Adams wrote me from Watertown: "The meadows and pastures are now filling up with the moths, and in places they fly out in small clouds." In a communication to the *Watertown Daily Times*, of August 22d, he writes: "At this date, any farmer of the county can walk his meadow or pasture and drive up moths in countless numbers, or, in places, in a small cloud." This, it should be remembered, is from a locality where the injuries done were moderate, compared to portions of St. Lawrence county. They may, therefore, be presumed to have been much more abundant there, but my only information relating to their appearance in that portion of the State is from Miss A. Clarkson, of Potsdam, who, under date of September 6th, writes: "The moths for the last three weeks have been flying in quantities, though much more abundant a few weeks ago than now. At West Stockholm, a means was devised for destroying them. Barrels were placed in the fields with water, on which was poured kerosene which was set on fire. The moths were attracted to the light and vast numbers killed."

Professor Riley, in a notice of the species, in the *American Naturalist* of November last (p. 914), states: "The moth has been excessively abundant all over the Eastern States this year, and as Mr Henry Edwards informed us, proved a positive nuisance in collecting in the neighborhood of New York city."

Description of the Moth.

The moth, shown in Fig. 33, has a slender body, and measures, on an average, one inch across its expanded wings. Its front wings are of a dull, yellowish color, and are only marked with rows of blackish scales between the veins, and with a black dot at the end of each vein on the outer margin; the fringe of the wings has a golden reflection. The hind wings are pale yellowish, with long, paler fringes. The thorax and abdomen are of the color of the wings. From the front of the head the two long, scaly palpi, folded together, project like a proboscis or beak, or, as in many cabinet specimens, diverge in a V, as in the figure.

Fig. 33.—The Vagabond Crambus moth—Crambus vulgivagellus, natural size.

The original description by Dr. Clemens (*loc. cit.*) is as follows: "Labial palpi luteous, dark fuscous externally. Head and thorax luteous; tegulæ with a fuscous stripe. Fore wings luteous, with numerous fuscous streaks in atoms along the veins, and two in the disk. Hind margin with a row of terminal black dots; cilia golden-hued. Hind wings yellowish; cilia whitish."

The Eggs.

From some of the moths from the Watertown cocoons which I had confined in a box with a piece of sod, eggs were obtained the last of August. Some of them were adhering slightly to the grass, but most of them were lying on the surface of the ground. It is, therefore, probable that the eggs are dropped at random in the grass—the larger number reaching the ground. At first they are of a pale yellow-green color, but later, as they approach the time for their hatching, they assume a pink shade. According to Professor Riley, who "found the egg-shells quite common in the earth of some sward, sent September 12th, by Mr. Adams, from a field that had been devastated by the larvæ, the eggs are pale yellow when laid, but become orange afterward: they are elongate-oval, very slightly broader at base than the top, and ribbed as in those of various butterflies, there being about twenty longitudinal, rather sharp ridges, and about thirty less marked transverse ones. The average length is 0.7 mm. and diameter 0.3 mm."*

*I am unable to reconcile with the above description some memoranda and rude figures that I had made of the egg, noting forty-four distinct longitudinal striæ, and the height (figured as an oblate-spheroid) to the diameter as two to three. Can my memory be at fault in referring these notes to *C. vulgivagellus?* The egg of a British species, *C. culmellus*, is thus described: "Elliptical, with an elongate depression on part of surface, very closely ribbed and finely reticulated; when first laid it is of a whitish-straw tint, changing in two days to flesh color, again onwards to salmon color, and then to deep pink, when it begins to hatch."

An enlarged view of the egg, represented in accordance with the above description, is given at *g* in Fig. 34, in connection with other phases of the insect. For the use of the figure, I am indebted to the Department of Agriculture at Washington, it having been one of the illustrations of the Report of the Entomologist for the year 1881–82.

FIG. 34.— CRAMBUS VULGIVAGELLUS: *a*, the larva; *b*, the larval case in grass; *c*, the cocoon in the ground; *d*, the moth, a dark specimen; *e*, wing of a lighter specimen; *f*, the moth at rest; *g*, the egg enlarged, its natural size shown beside it.

The Young Larvæ.

Some of the eggs which I took on September 1st, from the sod, and placed in vials for convenience of observation, gave out their caterpillars on the 7th. They were supplied from time to time with fresh and tender grass, in which they ate irregular holes, but without any evidence of appetite. All but one died within two or three weeks. The single survivor, after feeding sparingly, at long intervals, underwent a molting about September 15th. The greater part of the time was passed at rest, and whenever the drying of a blade of grass gave it a cylindrical form, the hollow thus made was chosen for its resting place.

The appearance of the young larva, a fortnight after its molting, when so little progress had been made in growth that it did not exceed one-tenth of an inch in length, was as follows: The head was elongate and shining black, with some white hairs projecting forward about one-half the length of its diameter; collar broad and shining black. Body dark brown, with a long lateral white hair on each segment, longer than those on the head and exceeding the diameter of the body; gradually tapering backward from the first segment; on each segment, two subdorsal verrucose spots.

Without farther progress, the larva died during the month — the

result, it is believed, of its not having been given the needed conditions for its hibernation. The period at which the hatching occurred, and the conduct of the larvæ during the time that they were observed, leaves scarcely doubt that their habit, in nature, is to feed but sparingly during the autumn, and to pass through one or two moltings, after which they retire to suitable quarters for their hibernation, remaining in a lethargic state until the starting of the new grass in the spring furnishes them with food.*

Present Condition of the Devastated Pastures.

Through the kindness of Mr. Adams, I am enabled to give the present appearance of the injured pastures in the vicinity of Watertown, N. Y. Under date of December 28th, he has written me: "The effects of the late raid still show in the absence of any blades of grass of *length*. Every thing is cropped short, except in small bunches here and there where manure was dropped. The grass has shown greenness this fall to a much less extent than would otherwise have been the case. There are evidently many dead roots as well as some live ones. Another raid in these pastures would probably prove fatal to the present sod."

It will be remembered that the depredations in Jefferson county were not nearly so serious as in St. Lawrence county.

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*Professor Riley has recently published in the Annual Report of the Department of Agriculture for the year 1881, observations made upon the young larvæ occurring in large numbers, in the District of Columbia. They are given here, as supplying an important part in the life-history of the species which I have endeavored to present:—

"The larvæ, if not too numerous, are difficult to find, on account of their nocturnal habits, but more particularly from their secluded mode of life. From the time of hatching to the assumption of the pupa state they remain nearly in the same spot. The newly-hatched larva spins a delicate white web, near or among the roots of the grass, and commences at once to feed upon the softer parts of some leaf near at hand, or to bore through the surrounding sheaths into the stem itself, near its base. Whenever they have settled they protect themselves by a delicate web, which they gradually cover with their greenish frass, forming a tube, in which they are entirely hidden from view. They are very sluggish, and, if the tube be disturbed, curl up into a helix-like roll. As they increase in size, the tube is extended either upward, when upon the ground, or downward, if somewhat above the surface, and the opening is often lined with bits of green grass."

Some interesting observations upon the tube of the mature larva are also given in connection with the above:—

"When the larva is full-grown its tube measures often, nearly 50 mm. (two inches) in length. A half-inch at the lower end is thicker than the rest, is rounded and closed, serving both as a retreat for the larva and as a receptacle for excrement. The upper or open end is usually very delicate, and is generally so constructed that if the larva is disturbed it closes entirely. When full-grown and ready to transform, the larva leaves its tube and commences to spin among the roots, and near or just beneath the surface of the ground, an elongate club-shaped cocoon, similar in appearance to the lower end of the larval tube. It is composed of smooth and delicate white silk, gummed over with earth. Both ends are rounded, the thicker end being about 6 mm. in diameter, and the narrow end about 4 mm."

Résumé of the Life-History of the Species.

The following is a résumé of the history of *Crambus vulgivagellus*, as it occurs in Northern New York, so far as we are prepared to give it:

The eggs are deposited in dry upland pastures and meadows during the latter part of August, and hatch in about ten days.

The young larvæ feed sparingly, and after one or two moltings they retire to winter quarters.

The hibernated larvæ commence feeding in the spring with the starting of the grass. When unusually numerous, their depredations attract attention during the second week in May, by rapidly-extending brown patches in pastures, from which the grass has been eaten down to the crown, but leaving the roots unharmed.

Their principal food-plant is grass (June-grass preferred). They also eat oats and wheat.

They feed principally by night, having rarely been seen engaged in feeding.

When not feeding, the larva occupies a cylindrical case or tube just beneath the surface of the ground, the upper portion of which is composed of bits of green grass cut for the purpose (possibly of excrementa), and fastened together by slight spinning.

The depredations, when serious, are conspicuously noticeable when the larvæ are about three-fourths grown — about the middle of May.

When nearly mature, the larvæ, from some unknown cause, sometimes congregate in immense numbers on the trunks of trees, near the ground.

When mature, about the 25th of May, they abandon their green cases, and build long and subcylindrical earthen cocoons, placed upright in the ground just beneath the surface.

They remain unchanged in the cocoons for two months or more, through June and July, when they transform to pupæ.

The pupal state continues for about two weeks.

The moths commence to emerge during the first week in August, and are abundant about the 20th of August in pastures and meadows where the larvæ abounded.

The larva is not subject to serious parasitic attack during its later stages; the proportion of parasites obtained from the cocoons is very small. In the earlier stages, continued rains, deficient food-supply, ants, and carabid beetles destroy many larvæ.

Natural Enemies.

It is not to be expected that the first year of insect attack should be marked by the presence of many natural enemies. Successive years at-

tract new foes, and continued observations bring them to our notice. Our long experience with the Colorado potato-beetle, *Doryphora decemlineata*, has made us acquainted with at least twenty-five species of other insects which prey upon it, and many species of Vertebrates which also destroy it. Thus far, only Carabid beetles and different species of ants have been noticed among insects, as devouring the Crambus larvæ. Mr. Adams has seen many of the former, eagerly exploring the pastures of Watertown for their natural prey. He has also informed me that while digging for cocoons, several species of Ichneumons were observed by him, which he presumed were parasitic on the larvæ. From the large number of cocoons received from him, only two species of parasites have been obtained by me, and these in but three examples.

LAMPRONOTA FRIGIDA *Cresson*.— The first of these has been kindly determined by Mr. Cresson as the species described by him as *Lissonota frigida*, in the *Canadian Entomologist* for 1868, v. i, p. 36, but subsequently referred to the genus *Lampronota*, of Curtis (*Trans. Am. Ent. Soc.*, iii, 1870, p. 161). It is shown in Fig. 35. It belongs to the subfamily of *Pimplariæ* of the *Ichneumonidæ*, and its original description is as follows: "♀ Black, somewhat shining; legs rufous, the coxæ, trochanters and posterior tibiæ and tarsi black; middle tibiæ and tarsi sometimes dusky; wings dusky hyaline, iridescent, nervures black, areolet small, petiolated; abdomen shining at tip; ovipositor longer than body; body densely punctured, most sparse on abdomen. Length 4 1-2 lines." *Hab.* — Grimbsy, C. W.

FIG. 35.—LAMPRONOTA FRIGIDA, parasitic on CRAMBUS VULGIVAGELLUS: twice the natural size.

As the wings of the insect have not been faithfully represented in the above figure, an enlarged drawing of them, made with a camera, is given in Fig. 36

FIG. 36.—Wings of LAMPRONOTA FRIGIDA Cresson, enlarged from the natural size shown beside them.

TACHINA ? sp. — The second parasite, of which three examples were obtained, is a fly, belonging to the *Tachinidæ*. Of this family a large number of species are parasitic upon caterpillars, attaching their eggs to the exterior of their body, not inserting them, as do the *Ichneumonidæ*. The larvæ which soon hatch from these eggs enter the caterpillar and feed upon it so slowly that it usually prepares for pupation, and frequently undergoes the

change, before the maturity and final development of the Tachina flies. In appearance these flies resemble several of our common species of house-flies, having short and broad wings, stout and bristly bodies, and large eyes. Fig. 37 represents a species of the family, *Nemorœa leucaniæ* Kirkp., which is of great benefit in checking the ravages of the army-worm, *Leucania unipuncta*, for when the pest abounds it is usually accompanied by its parasite, which follows the hosts and deposits its eggs upon them near the head, as shown in the figure, and causing the death of the larger number of the invading army.

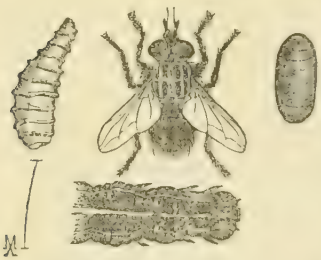

FIG 37.-NEMORŒA LEUCANIÆ; the larva, fly and puparium; also, its eggs placed upon the forepart of an army-worm, on which it is parasitic.

The Tachinid reared from the Crambus cocoons is one of the smallest that I have seen, surpassing but little the common house-fly, *Musca domestica*, in size. Its eyes are large; its thorax bluish, striped with black; its abdomen quite bristly and presenting changeable patches of gray and black as viewed in different lights. It has not been specifically determined. Many of the species are so similar in appearance, and there appears to be so great a range of variation in a single species, that their correct determination, in some of the genera, is a very difficult task, involving an amount of study which has not been given to them.

The above Tachina has given an illustration of secondary parasitism, which is always interesting, although not infrequently met with among the insects which prey upon one another. The Tachina fly, while destroying the Crambus, has, in its turn, been attacked and destroyed by a hymenopterous insect — one of the *Chalcididæ*. Of the three Tachinid puparia found among the Crambus cocoons, one gave out the fly noticed above, from another a Chalcid emerged, and the third was discovered with a hole eaten in one end, through which the head and front pair of legs of another example of the same species was projecting, evidently caught and fastened by some means in the act of emerging, and dying in this position.

PERILAMPUS VIOLACEOUS *Dalm.* — The Chalcid, as determined by Mr. L. O. Howard, is *Perilampus violaceous* Dalman. It is a beautiful little insect in its brilliant deep violet color throughout, except its dusky feet. Its short antennæ, not so long as the transverse diameter of the head, are closely jointed. The head is short and broad, with ovate eyes. The deeply punctured thorax is large, longer than the abdomen, protuberant, and ending in a blunt point behind. The abdomen is smooth, with short downy hairs, and is trigonate in form. The front wings

have a stout vein running into the costal margin at its middle, throwing off a short branch inwardly; their expanse is 0.42 of an inch.

The insect was found dead in the box with the cocoons and puparia, and it is not known, therefore, when it emerged. An example of the same species in my collection bears the label, "May, 1875, from some lepidopterous pupa."

CRYPTUS MUNDUS *Provancher.*— A third parasite upon the Crambus is mentioned by Professor Riley,* as an undetermined *Cryptus*. It has recently been determined by Mr. Cresson as *C. mundus*.

Probabilities of Future Attacks.

Questions of great interest to those who have suffered from the recent depredations of this destructive insect, and to those who have been studying its history, are these: Will it reappear the coming season and repeat its injuries? Will the injuries be largely increased, from the immense number of eggs that have been deposited by the "clouds" of moths? Will the species hereafter continue as a serious grass-pest? The first two of the above queries will have been practically determined before these pages can reach the public; and furthermore, they are virtually covered by the last.

Our knowledge of the history of this species compels us to look upon the recent demonstration as an exceptional one. It had never, so far as we know, occurred before, and the records of similar attacks by other species enable us to say that it will not necessarily be repeated the present year and in following years. Further, we may venture to record our belief that they will not continue hereafter. Indeed, many years may pass before we shall see it again in injurious numbers. Had it been, as at first supposed, a visit from the "army-worm," we could have predicted that it would not recur the following year, for the immense hosts of that species are always attended by their parasitic foes which so effectually destroy them that it seems impossible that two "army-worm years" can follow, in the same locality. Unfortunately, the vagabond Crambus has not invited such parasitic attack. Predictions of its future, therefore, may only rest on probabilities.

The immense numbers of this species in its recent occurrence was simply the result of a combination of circumstances which had not occurred before. For reasons unknown to us, all the conditions had been favorable to the development of the perfect insect. Of the eggs laid by the parent moths the preceding year, nearly all produced their young. The tender larvæ were exempt from attack or disease during their autumnal growth. During their hibernation they escaped the mortality which ordinarily attends this stage; and the weather of early spring

**Ann. Report of the Dept. of Agriculture* for 1881, p. 181.

and other attendant circumstances were just that best adapted to their need. A combination existed, in which heat, cold, drouth, rain, dews, snow, frosts, other insect and animal life, were factors, in such association, as, on the doctrine of chances, may not be again presented for many years to come.

Were we to base an opinion upon seasonal conditions, we would predict that the unusual high temperature of the month of December last, has been unfavorable to the lethargic repose, during the early winter-time, of the young Crambus caterpillars, which repose we believe to be essential to their safe hibernation; and that an almost entire absence of snow has exposed them in their retreats to destruction from a prolonged activity of predaceous insects, from birds, and from other enemies. It seems, therefore, probable that from the above causes, the number of the hibernating brood has already been greatly reduced.

Preventives and Remedies.

Burning.— If grass lands which the Crambus has infested can be burned over, either by setting fire to straw scattered over them, or otherwise, in the late autumn or early spring, before the starting of the new growth, a large proportion of the caterpillars hibernating among the roots or blades of grass would be destroyed.

Application of ashes, lime, plaster, dust, etc.— As soon as an examination shows that the young caterpillars have commenced feeding in the spring, the recommendations made on page 131 should be resorted to and their efficacy tested.

Rolling the ground.— The question should be settled as soon as possible, if the caterpillars feed only by night. This can be done where they are abundant, by an examination with a lantern. If nocturnal only, large numbers could be killed by rolling the ground after dark.

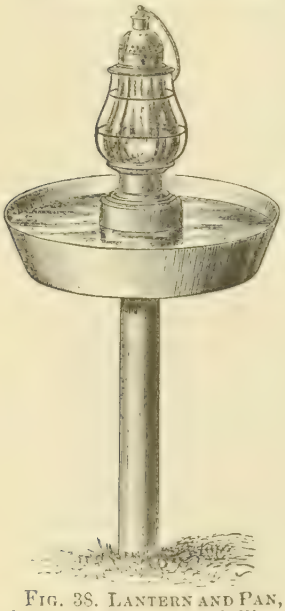

Fig. 38. Lantern and Pan, for attracting and killing moths.

Attracting and drowning.— The moths may be attracted to lights and destroyed — perhaps in larger numbers if a bait of molasses and vinegar or beer be used with the light. Fig. 38 shows an arrangement which has been successfully used for destroying similar insects, and which will doubtless prove serviceable with this species, as experiments at Potsdam have shown it to be readily drawn to light. A bright-burning lantern is placed upon a block of wood in the center of a pan containing the liquid for attracting and drowning the moths, fastened to the top of a post or stake inserted in the ground. The cost of such an arrange-

ment would be so inconsiderable that several lanterns might be used in each field.

Deep plowing.— A recurrence of an attack in a pasture or meadow may be prevented by deep plowing in the autumn, at any time after the middle of September. The eggs or the young larvæ would be crushed or so deeply buried that their death must necessarily follow.

Use of gas-lime.— It is believed that a liberal dressing of the pastures during autumn or winter with gas-lime (as suggested on page 53) of strength and quantity not sufficient to destroy the roots, will be very efficient in killing the young larvæ.

Crambus exsiccatus Zeller.

The Dried Crambus.

Ord. LEPIDOPTERA: Fam. PYRALIDÆ.

ZELLER: Chilonidarum et Crambidarum gen. et spec.; in Programm der Koenigl. Realschule in Meseritz, 1863, pp. 37,38 no. 88.

LINTNER: in Alb. Eve. Journ., of July 1, 1881; in Husbandman [Elmira, N. Y.], Sept. 14, 1881; in Science [N. Y. City], for Oct. 1881, ii, p. 467.

RILEY: in American Naturalist, Sept. 1881, p 750 (mention).

GROTE: in Canad. Entomol., xii, 1880, p. 78 (habitat).

The caterpillar of this species, of which the moth is represented in Fig. 39, was collected in St. Lawrence county, N. Y., on or about the 20th of May, in company with examples of *Crambus vulgivagellus*, which abounded then in the pastures of Northern New York, as noticed in the preceding pages. The larvæ collected at that time were not observed with sufficient care to detect more than two species (those subsequently ascertained to be *C. vulgivagellus* and *Nephelodes violans*), but it is probable that but little difference could have been detected between the two Crambids. They were confined in a box with sod, and a few days thereafter, when a number had died, and all but two or three had disappeared from the blades of grass, one of the Larvæ, not distinguishable at the time from the others, was removed to a small tin box with some tender grass for its food. It ate but little after its confinement, for on the 31st of May, it was found to have made a slight cocoon between the blades of grass, of so few threads that it could be distinctly seen in its somewhat contracted form, indicating approaching pupation. It was observed daily, and on the 20th of June it had thrown off its caterpillar covering and changed to its pupal state. The cocoon, if such it might be called,

FIG. 39 — CRAMBUS EXSICCATUS — twice its natural size.

was so slight that the pupa, unattached, rolled from its shelter while being examined, and was easily replaced.

The pupa is three-eighths of an inch long by rather more than one-third as broad. Its color is reddish-brown, with its flattened, broad anal tip blackish, and bearing two diverging microscopic hairs. The stigmata are elevated, broadly oval, of a dark brown color. The incisures of the segments are well marked; the last three segments rounding rather abruptly to the tip. The wing-covers reach to the eighth segment, and occupy more than two-thirds of the entire pupal length. The eyecases are prominent; the antennæ cases extend to nearly the tips of the wings.

The moth emerged from the pupa on the 19th of June, giving for its pupation a period of fifteen days. The brief period required for the transformations of this species is quite interesting from the contrast which it presents to the prolonged larval stage, preparatory to pupation, of *Crambus vulgivagellus*. This latter feature seems not to be characteristic of the *Crambidæ*, if we may judge from the various times during the spring and summer when the moths are known to emerge from their pupæ. From a paper, by Mr. E. L. Ragonot, of Paris, giving the period of apparition of nineteen species of *Crambus* occurring in Great Britain,* we find as follows: May to July, one species (*C. craterellus* L.); May to September, one species (*C. perlellus* Sc.); June and July, four species;† June, July and August, three species;‡ July and August ten species.§

There may be a second brood of *C. exsiccatus*, as of some of the earlier appearing European species, for an example in my collection bears as the date of its capture by me, September 3d. It has been taken in the Adirondack Region of New York, by Mr. W. W. Hill, on the 7th of July.‖

It is probable that the larval life of the species is similar to that which has been given of *C. vulgivagellus*, and that it is passed in a tubular gallery, spun by the caterpillar, such as is constructed by the several species of *Pyralidæ*, recently observed and recorded by Mr. W. Buckler. Whether the gallery is built above or within the ground remains to be seen, for the habits of the several species differ in this particular. Thus, while the adult larval gallery of *C. vulgivagellus* is found within the soil, in another species, of which Mr. Buckler has

**Entomologist's Monthly Magazine*, xvii, 1880, pp. 15–17.

†*C. dumetellus* Hb., *C. uliginosellus* Z., *C. pascuellus* L., *C. myellus* Hb.

‡*C. silvellus* Hb., *C. margaritellus* Hb., *C. culmellus* L.

§*C. alpinellus* Hb., *C. verellus* Zk., *C. ericellus* Hb., *C. Warringtonellus* Stt., *C. hamellus* Thunb., *C. furcatellus* Zett., *C. latistrius* Haw., *C. inquinatellus* S. V., *C. contaminellus* Hb., *C. lithargyrellus* Hb.

‖*Seventh Ann. Rept. Survey Adirondack Region of N. Y.*, 1880, p. 391.

given the life-history,— *C. Warringtonellus* (*Ent. Month. Mag.*, xviii, 1881, pp. 129–131), the larvæ, "when near full growth, inhabit tubular galleries, two inches long, of irregular figure, firmly attached to the grass in an upright position with the lower end touching the ground."* Of the case occupied by the young larva, in the autumn, of this species, it is stated : "By the middle of November, the case or gallery it has constructed is a quarter of an inch long, composed outwardly of finely comminuted grassy particles firmly attached to the grass, about three-quarters of an inch above the ground." Of some other English species, Mr. Buckler makes the following statements : *C. culmellus* hibernates in little tubular galleries spun in an upright position among the grass. *C. contaminellus* has its hibernating gallery attached to the whitish sheaths of grass or to stones, covered with fine greenish frass, or grass and earth. *C. geniculus* hibernates in a gallery close to the earth or partly beneath the surface, composed of dirty brown silk.

Crambus exsiccatus was originally described by Professor Zeller from a number of examples (three males and seven females) received from Illinois. It also occurs, according to Mr. Grote, in Canada, Maine and Vancouver. A closely resembling species, *Crambus undatus* Grote, has been described from California (*Canad. Entomol.*, xiii, 1881, pp. 35, 66), differing mainly in its smaller size and absence of the indentation of the outer band below the middle of the wing, just above the submedian fold. Professor Zeller compares *C. exsiccatus* in size and shape to *C. fascilinellus*, and states that it is the *C. fascisquamellus* of Kollar, *in litt.*

Should this species ever multiply so as to become obnoxious, the same remedies may be employed against it as recommended for the Vagabond Crambus.

Anarsia lineatella Zeller.

The Peach-twig Moth.

Ord. LEPIDOPTERA : Fam. TINEIDÆ.

ZELLER ; In Isis, for 1839, p. 190 (original description).

CLEMENS ; in Proc. Acad. Nat. Sci. Phila., for 1860, p. 169 (described as *A. pruinella*); also the same in Tineina of N. America, (Stainton ed.), 1872, p. 128; Ib., p. 36 (*in litt.* to Stainton, identified with *A. lineatella*).

CHAMBERS ; in Canad. Entomol., iv, 1872, p. 208 (identical with *pruinella*); in Bull. U. S. Geolog.–Geograph. Surv. Terr., iv, 1878, pp. 112, 129 (food-plants and references).

*The cocoon of this species differs also from that of *C. vulgivagellus*, in that instead of being subcylindrical, it is "oval, half an inch long and a quarter of an inch wide, made of similar materials to those of the gallery, but is more tough and stronger and sunk partly in the earth."

Saunders; in Ann. Rept. Ent. Soc. Ontario, for 1872, (1873), p. 15 (infesting strawberries).

Glover; in Ann. Rept. Commis. Agricul. for 1872, (1874), p. 112, f. 1 (habits, etc.).

Comstock: in Proc. West. N.Y. Horticul. Soc. for 1878, p. 13 (description, depredations, and figures); in Rept. Commis. Agricul. for 1879, (1880), p. 255 (in peaches).

Lintner: in 38th Ann. Rept. N. Y. St. Agricul. Soc. for 1878, (1879), pp. 69–72; the same in Report on Some Inj. Ins. of the Year 1878, pp. 12–14.

Examples of the above insect with twigs infested by it were sent to me, in the month of June, for examination and identification, accompanied by the following note: "The inclosed insects are very injurious to the terminal branches of the peach-tree. They deposit their eggs, either very early in the spring, just as the buds are swelling, or the fall previous. The terminal buds of all the higher and outer branches are so stung, and although these buds develop into seemingly fine branches, in a few weeks they wither and drop off. The centers of the twigs are first destroyed by these insects while in the larva state. I placed several of the twigs in a large bottle, and secured the inclosed specimens from them. One of the pupæ seemed to be destroyed by some parasite, as it looks as if it was filled with eggs."

From the above statement of the habits of the insect, and the effect of its operations upon the twigs, the specimens of the moth received, although in too poor condition for identification if they had been sent alone, were readily referable to the insect popularly known as the peach-twig moth. From its small size and structural characters, it is numbered among the Microlepidoptera (small lepidoptera), of the family *Tineidæ*.

Description of the Moth and Larva.

In 1860, Dr. Clemens bred the moth from larvæ which he had found on the 16th of June, infesting plum-trees, and described it (*loc. cit.*) under the specific name of *prunella*, doubtfully referring it to the genus *Anarsia*. The description is as follows: —

"Head and face pale gray; thorax dark gray. Labial palpi dark fuscous externally, and pale gray at the end; terminal joint gray, dusted with dark fuscous. Antennæ grayish, annulated with dark brown. Fore wings gray, dusted with blackish-brown, with a few blackish-brown spots along the costa, the largest in the middle, and short blackish-brown streaks on the median nervure, subcostal, in the fold, and one or two at the tip of the wing; cilia fuscous gray. Hind wings fuscous gray; cilia gray, tinted with yellowish." The moth, enlarged, is shown in Fig. 40.

Fig. 40.— The Peach-twig borer — Anarsia lineatella Zeller.

Later, it was ascertained by Dr. Clemens that the insect occurred also in Europe and had been previously described as *Anarsia lineatella*, thereby adding it to the long list of insect pests which Europe has given us. Professor Riley obtained specimens of the same moth from peach twigs, and on submitting examples to Professor Zeller, they were pronounced identical with the European insect.

The larva has been described by Mr. William Saunders, as follows: "The head is rather small, flattened, bilobed, pale brownish-yellow, darker in color about the mouth, and with a dark brown dot on each side. The body above is semitransparent, of a reddish-pink color, fading into dull yellow on the second and third segments; anterior portion of second segment smooth and horny-looking, and similar in color to the head. On each segment are a few shining reddish dots (yellowish on the anterior segments), or faintly elevated tubercles, from each of which arises a single, very fine, yellowish hair, invisible without a magnifying power: these dots are arranged in imperfect rows, a single one across the third, fourth and terminal segments, and a more or less perfect double row on the remaining segments. The under surface is of a dull whitish color, becoming faintly reddish on the hinder segments, with a few shining whitish dots; those on the fifth, sixth, eleventh and twelfth segments, being arranged in transverse rows, in continuation of those above. The feet and prolegs are yellowish-white, the former faintly tipped with dark brown. It spins a slight silken thread, by which it can suspend itself for a time, at a short distance from its place of attachment.

Operations of the Larvæ.

The first published notice of the operations of this insect in this country which we have met with, appears in the Report of the Entomologist (Mr. Glover) of the Department of Agriculture at Washington, published in the Annual Report of the Department, for 1872. Mr. Glover states: —

"In examining peach orchards in the neighborhood of the Maryland Agricultural College, about the first week in May, almost all the young twigs of the trees were observed to be killed at the extreme end for a distance of from one inch to two and a half inches, and the terminal buds entirely destroyed. On cutting open the dying twigs, the injury was found to be caused by a minute caterpillar, which, entering a twig near the bud, had entirely eaten the pith and the interior, leaving only its 'frass' and the exuding gum to mark the spot where it had entered. When confined in a glass case, after about a couple of weeks, several of the larvæ left the injured twigs and formed very loose cocoons on the sides of the box or among the rubbish and old leaves

lying scattered on the earth, and in about six to ten days the perfect moth appeared [last of May]. * * * * The tail of the pupa is attached to a little button of silk in an exceedingly slight cocoon. There was scarcely a single young tree in the peach orchard examined that was not more or less injured by this little pest, and at least as many as from twenty to fifty injured twigs were found on some very young trees. After the insect leaves the twig, the injured part dries up and breaks off. This insect was also seen, though in much smaller numbers, last season, in Maryland and Virginia. Apple-trees are also similarly injured in a like manner in Maryland, and it is probable that the damage was done by the same worm.

"The larvæ are about 0.25 inch in length; head black; body dark reddish-brown, with lighter rings — the third ring being more conspicuous and whitish. The moth is quite small, and measures from 0.40 to 0.60 of an inch in expanse of wings, and is of a pale gray color with a few blackish spots on the upper wings."

Professor Comstock has written of the ravages of this insect in Western New York. His statement of its habits differ in some particulars from that of Mr. Glover, above quoted. According to his observations, "it destroys the terminal leaf-bud, and sometimes the lateral buds, in the following manner: The young caterpillar begins its work in the spring at the time, or soon after, the shoots begin to grow. These, when from one-half to one inch in length, are punctured at the base and eaten off. The leaves of the bud unfold and then wither. The twig, although severed, does not drop off, but is held in place by a gummy substance. All the twigs on some trees are destroyed, especially on the two-year old trees. Mr. Green, of Clifton, N. Y., had one hundred trees infested. The larvæ became full-grown during the latter part of May or early in June. Specimens collected June 10th, were found to have changed to pupæ June 14th." The time of their emerging as moths was not observed, as they were found dead in their breeding-cage some time during the summer.

Writing later of this species, Professor Comstock records the interesting fact that he has found the larvæ within peaches grown in Blackstone Island, Virginia, and also in peaches on the grounds of the Department of Agriculture at Washington. The larva leaves the peach before transforming, and suspends itself to the outside of the fruit, spinning no cocoon at all. It was ascertained that the species was double-brooded, the early brood which feed in the terminal twigs and buds, maturing, in the latitude of Washington, during May and June, and the later brood — the fruit-inhabiting — found during the latter part of July and August and maturing during September.*

*Rept. Commis. Agricul. for 1879, (1880), p. 255.

New York Localities.

The localities in New York where injuries by this insect have been recorded are Ithaca, Rochester, Lockport, Clifton and Jordan Station. Its operations at large have not come under my personal notice, but its presence, to an injurious extent, in the eastern portion of our State is very probable, from statements made to me three years ago, of an affection of some peach-trees in Schenectady and Albany. The moth has been captured by me in Schoharie, N. Y., on June 5th.

Like many of our New York *Tineidæ*, it occurs also in Texas. It extends northwardly into Canada, where it is believed by Mr. Saunders to have been introduced in strawberry roots from the United States.

Injurious to Strawberries.

In the *Annual Report of the Entomological Society of Ontario for the Year* 1872, published in 1873, we learn that the ravages of this insect are not confined to the peach, plum and, perhaps, the apple, but that it also occurs under very different conditions and affecting a very different food-plant. In this report, Mr. Wm. Saunders, the editor of the *Canadian Entomologist*, describes the insect under the name of the *strawberry-root* or *crown borer*. During the years 1868 and 1869, it was very destructive in certain grounds at St. Thomas, Ontario, the caterpillar eating irregular channels in various directions through the crown and larger roots of the strawberry plants, causing them to wither and die, and thus destroying a large proportion of the plants. Mr. Saunders gives a minute description of the caterpillar, narrates its history and states that it probably has two annual broods.

Specimens of the larvæ obtained late in the season were found alive within their silken cocoons on the 12th of January, rendering it probable that this brood hibernate in the larval state and transform to pupæ in the spring, a short time before their reappearance in their perfect state.

Another "Strawberry-crown Borer."

The above strawberry-root or crown borer, of Saunders, should not be confounded with the strawberry-crown borer, of Riley, — an insect belonging not to the order of Lepidoptera, but to the Coleoptera, of the family commonly known as snout-beetles or weevils.

This latter insect has been described and figured in its larval and perfect stages by Professor Riley (*Third Report on the Insects of Missouri*, p. 42, fig. 14, 1871) as *Analeis fragariæ*.* So far as known, it is confined to the Mississippi valley, and has not, to our knowledge, been reported from the Eastern States. Its habit of boring down

*Now known as *Tyloderma fragariæ* (Riley).

through the crown of the strawberry plant into the pith and eating through the more woody portions is very similar to that recorded of the *Anarsia lineatella*, and the ravages of the two insects, in localities where they conjointly occur, are liable to be confounded. The general use of common names for our insects, birds, fishes, mammals, etc., very often results in serious confusion, when, with little difficulty, the scientific name, which always indicates the object referred to, could be acquired.

Parasitic Attack.

It is gratifying to know that, in all probability, this destructive pest has already been attacked by a parasite which promises to perform an effective part in checking its ravages.

The "pupa apparently filled with parasitic eggs," referred to in the communication accompanying the examples sent to me, was the dead body of a caterpillar, distended to its utmost capacity by the presence of no less than fifty-one pupa-cases of apparently some Chalcid species.* They had been crushed in their transit through the mail, preventing the perfect insect being taken from them, or even an approximate reference of their relationship.

Remedies.

Should the increase of this insect not be prevented by parasitic agency, then the most effectual means of arresting it will be the cutting off of the infested terminal twigs of the trees upon which it occurs — readily to be distinguished by the drying up of the leaves — and burning them with their contained borers. This must be done during the month of May, or early in June, before the larvæ have attained their maturity, after which they leave their burrows to seek some sheltered place beneath the loose bark of the trunk, leaves upon the ground, or elsewhere, where they may construct their cocoons and undergo their final transformation.

Strawberry plants giving indication of their presence should be promptly uprooted and burned.

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*Mr. L. O. Howard (our authority in the *Chalcididæ*) expresses the belief (*American Naturalist*, xiii, 1882, p. 150), based upon the mode of occurrence, that these were the cocoon-like cells of a Chalcid species belonging to the genus *Copidosoma* of Ratzeburg, and congeneric with others found by him, distending to the utmost the larval skins of another example of *A. lineatella*, and also of *Lithocolletis Fitchella* Clem., *Gelechia pinifoliæ* Chamb., and *Plusia brassicæ* Riley. From a single example of this latter species the almost incredible number of two thousand five hundred and twenty-eight parasites, by actual count, emerged.

Bucculatrix pomifoliella Clemens.

The Apple-leaf Bucculatrix.

Ord. LEPIDOPTERA: Fam. TINEIDÆ.

CLEMENS: in Proc. Acad. Nat. Sci. Phila., 1860, p. 211 (original description; republished in Tineina of N. Amer. (Stainton ed.), 1872, p. 146.

PACKARD: Guide to Study of Ins., 1869, p. 354, pl. 8, f. 16 (description as *Lithocolletis curvilineatella*); Ib., 7th edit., 1880, (as *Bucculatrix pomonella*); 1st Rept. Ins. Mass., 1871, p. 24 (description).

RILEY: 4th Rept. Ins. Mo., 1872, pp. 49–51, f. 23; in Amer. Entomol., iii, 1880, p. 23 (habits, remedies, etc.).

CHAMBERS: in Canad. Entomol., v, 1873, p. 150 (brief description); in Bull. U. S. G.-G. Surv. Terr., iv, 1878, pp. 112,132 (references, etc.); in Amer. Entomol., iii, 1880, p. 50(habit).

ZELLER: Beitr. zur Kennt. nordamer. Nachtf., iii, 1875, p. 147 (critical remarks).

LINTNER: in Count. Gent., lxv, 1880, p. 263 (general notice).

BARNARD: in Amer. Entomol., iii, 1880, p. 76 (cocoons).

WALSINGHAM: in Trans. Amer. Ent. Soc., x, 1882, p. 204 (synonymy, etc.).

It is but recently that this species has attracted attention as an insect pest, and as yet its injuries have not become very serious: but as it appears to be upon the increase, it is quite important that a knowledge of it should be diffused in order that means may be resorted to that its distribution may be checked before it shall become decidedly noxious.

Its Several Stages.

It first arrests attention during its pupation when its numerous small white cocoons may be observed thickly clustered upon the smaller twigs of the apple-trees. The cocoons, which, from their small size, are often mistaken for insect eggs, are spun by a little caterpillar which makes its appearance upon the young leaves soon after they unfold, in the month of May. The caterpillar is said, by Chambers, at first to mine the inner substance of the leaf, and later to operate as an external feeder. It is sprightly in its motions, and readily disturbed, when it drops from the leaf and hangs suspended by its silken thread, until the cause of its alarm has ceased. It is described by Dr. Clemens as of a cylindrical form, tapering somewhat at the ends, with its joints so rounded as to resemble a series of strung beads, of a dark yellowish-green color, tinged with red on the front segments, and with scattered, short, black hairs, which are more numerous on the back of the first segment. Its head is small, of a brown color, and ellipsoidal in shape. It has the usual number of feet (sixteen), viz.: three pairs of true legs (thoracic), four pairs of very short abdominal legs and one terminal pair (prolegs). At maturity it measures about one-half of an inch in

length. It attains its growth during the early part of June, when it spins its cocoon, usually upon the surface of the bark, and, unless it occurs very abundantly, at or near the branching of the twigs.

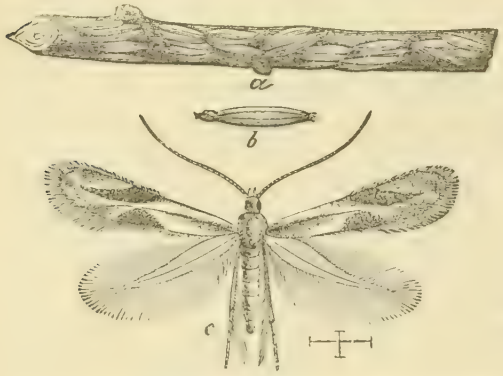

FIG. 41.—Apple-leaf Bucculatrix, BUCCULATRIX POMIFOLIELLA: *a*, piece of twig covered with cocoons; *b*, cocoon enlarged; *c*, the moth, enlarged.

The cocoon, shown at *a* in its natural size, almost covering a small twig, and at *b* enlarged, is white or whitish, about one-fourth of an inch in length, of the diameter of an ordinary pin, and is characterized by several prominent longitudinal ribs; in some examples before me, there are six of these ribs. When ready for its transformation, the amber-brown pupa, according to Riley, pushes itself partly out of the cocoon, and the little moth emerges during the month of April, and deposits its eggs on the young leaves. The moth is of so small a size — but a little more than one-fourth of an inch in expanse of wings — that it would not readily be noticed even when in flight about the apple-trees. Its appearance, enlarged, is shown at *c*, in Fig. 41.

There are two, and possibly three annual broods of this insect. In the latitude of St. Louis, Mo., the caterpillars have been observed more numerously during the month of September than at any other time. The cocoons of this brood were spun during the latter part of this month and in October, from which the moth would be produced the following April.

Geographical Distribution.

The insect appears to be local in its nature. Nearly all the notices of it within this State have come from its western portion. A correspondent of the *Rural New Yorker* (in 1870) states that in visiting an orchard of 800 apple-trees in Brighton, near Rochester, his "attention was directed to the branches of the trees, which were thoroughly lined with these insects inclosed in the silk-like cocoons, and tightly attached to the small branches." A correspondent of the *American Entomologist*, writing from Scottsville, Monroe Co., N. Y., records their introduction into his orchard: "They were first observed here last year [1879]. They are deposited on the bark near the forks, and number from two to twenty per tree." At Ithaca, N. Y. (midway between the eastern and western limits of the State), they have been observed, scattered sparingly over the branches — not in groups, as in the western counties.

The species occurs in remote portions of the United States. Inquiries in relation to it have been received by me from Massachusetts. A specimen of it, collected in Texas, is in the Cambridge (Mass.) Museum, and it occurs also in Missouri, in the vicinity of St. Louis.

Parasites.

The ravages of this pest have already received quite a check from parasitic attack. Small as the insect is, there are insects still more minute which are specially adapted for seeking it out and preying upon it.

In the 4th Report on the Insects of Missouri, 1872, p. 51, mention is made of a minute Chalcis-fly, allied to the genus *Eulophus*, preying upon the apple-leaf Bucculatrix, many of the cocoons having been found with minute round holes at one end, through which the parasites had emerged.

A number of Chalcids were bred by me in 1880, from some Bucculatrix cocoons received from Western New York, which were believed to be the same as those above referred to. Some of them were accordingly forwarded to Professor Riley for comparison with the examples obtained by him. They proved to be identical, and to belong to the genus *Cirrospilus;* and as Professor Riley had been studying the species, he has kindly given me the manuscript of its description, together with an excellent figure of it, for publication in the present notice.

CIRROSPILUS FLAVICINCTUS *Riley*, nov. sp. (Fig. 42.)

Male.— Length, 1.3 mm.; expanse, 2.8 mm. Antennæ seven-jointed; scape originating low down, as long as three succeeding joints together, which are subequal; no ring-joints; club rather longer than preceding joint, one-third broader, with the two divisions faint. Body polished and very finely imbricate above. Color bright yellow, prettily marked with black, having a blue metallic reflection, especially on the thorax as follows: antennal articulations, especially at the base of pedicel (joint 2); the eyes and top of head between them; the thorax above except a broad transverse band including two joints next the base, the upper surface of the hind coxæ and (in one specimen) the terminal half of the hind tibiæ. Tips

FIG. 42.—The Cirrospilus parasite of the apple-leaf Bucculatrix: the natural size shown in the hair-lines.

of all the tarsi slightly dusky. The yellow band on the abdomen and the antennæ less bright than the rest. Ocelli, brown.

Female.— Length, 1.6 mm.; expanse, 3.3 mm. Differs from male in having only a mesoscutal yellow spot, a narrow yellow line around inside of eyes and the legs yellow, except hind coxæ, femora above, and tips of tarsi. The antennæ are more hirsute, slightly shorter and yellowish-brown, with scape black. The thorax has a distinct bluish hue.

Described from one male and one female received from the late B. D. Walsh, bred by him, in May, from *Bucculatrix pomifoliella;* two males, from Professor J. A. Lintner, bred from same species, and two males and two females, bred by myself, between March and July, 1874.

Professor Riley has also bred another parasite from the *Bucculatrix*, also one of the *Chalcididæ*, belonging to the *Encyrtinæ*. This subfamily embraces a large number of small, active Chalcids, many of which are of special value to us from the predilection which they show for attacking the various and destructive species of bark-lice. Mr. L. O. Howard, of Washington, has recently described eleven new species of this group,* which are parasitic on *Coccidæ;* while in Europe a publication upon the group, by Dr. Mayr, in 1875, shows the following great preponderance of the bark-lice parasites: one species upon a hymenopterous insect, two upon Coleoptera, four upon lepidopterous eggs, and sixteen upon lepidopterous larvæ, four upon Diptera, one upon aphides, and *thirty-nine upon bark-lice*— these last being over fifty-eight per cent of all the known species.

This second parasite has been described by Mr. L. O. Howard, to whom I am indebted for the following description and figure and the permission to publish them:

ENCYRTUS BUCCULATRIX *Howard*, nov. sp. (Fig. 43.)

Female.— Length of body, 1.2 mm; expanse of wings, 2.5 mm. Greatest width of fore-wing, 0.35 mm. Antennal scape slightly widened below the middle; pedicel as long as succeeding three joints; funicle joints gradually increasing in length and thickness; club, long, oval, as long as preceding four joints together. Wings, perfectly clear; marginal, postmarginal and stigmal veins extremely short. Ovipositor slightly exserted. Head slightly punctured, thorax very slightly shagreened; abdomen smooth. Color black, with a slight lustre, especially upon cheeks, mesoscutellum and hind coxæ. Middle legs with trochanters, femero-tibial articulations, a mesial tibial band and the distal ends of tibiæ, including spurs, whitish; front and hind legs the same, with the exception of the mesial tibial band; all tarsi whitish, often with a yellowish tinge; antennæ, except scape, yellowish-brown with gray hairs.

FIG. 43.—The Encyrtus parasite of the Apple-leaf Bucculatrix; enlarged to about fifteen diameters.

Report Commis. Agriculture for 1880, pp. 360–367.

Described from many female specimens; male, unknown. Parasitic upon *Bucculatrix pomifoliella* Clem.

Mr. Howard also informs me that in examining a bottle of alcoholic specimens of the above species in Professor Riley's collection, he had found a number of examples of a Chalcid which he thought might be also parasitic upon *Bucculatrix pomifoliella*, or a secondary parasite. The material was in too poor condition for determination and description. One specimen of a Braconid had also been found in the collection, marked "parasitic upon *Bucculatrix pomifoliella*."

Psocus Bred from Bucculatrix Cocoons.

Two specimens of *Psocus* were also received by me from Professor Riley, which he had bred from the Bucculatrix. They were sent to Dr. Hagen for determination, and were found by him to be identical with *Psocus semistriatus* Walsh (*Proc. Acad. Nat. Sci. Phila.*, 1862, p. 361), as compared with types in the Museum received from Mr. Walsh. Possibly, *P. semistriatus* may prove to be the same as *P. quietus*, which had been previously described by Dr. Hagen from an example from the State of New York and another from Georgia (see *Proc. Ent. Soc. Phila.*, 1863, p. 167).

It is probable that this Psocus is not a true parasite upon the Bucculatrix, but is associated with it as a scavenger, feeding upon the exuvia of the larva. Dr. Hagen has written me as follows of these *Psocina* : "No Orthopteron nor Pseudoneuropteron has been observed to live as parasites, and I think that they are not parasitic. But certain species prefer to live as *inquilines*, and one species was described by Linnæus, more than a century ago, as Hymenopteron. Some species of *Caecilius* and *Elipsocus* live here and in Europe in willow and oak galls. Two species were brought from Brazil by Mr. B. P. Mann, which he considered as parasites of the coffee-leaf miner. Such Psoci like to feed on cast skins; and, perhaps in the case of *Psocus semistriatus*, on the dry skins of the Bucculatrix caterpillar, as my experience has shown me the fondness of many Psoci for larval skins."

The *Psocidæ* are a low form of insects constituting a family in the division of Pseudoneuroptera. They are small forms, measuring in length from 1 mm. to 8 mm.: *Psocus venosus*, our largest species, which lives on apple and maple trees, has an expanse of wings of from 12 mm. to 15 mm. (about 0.5 to 0.6 in.). They occur in both the winged and wingless states, and somewhat resemble plant-lice in general appearance. The larger number feed on dry vegetable substances and lichens. They are quite common, and may be often found congregated in large companies on trunks of deciduous trees and among the herbage of some of the evergreens; they also frequently occur in houses. *Atropos divinatorius* (O. Fabr.), originally described from

Greenland, may often be found in books and in insect cases; it has been discovered in the Mammoth Cave, Kentucky, upon animal remains.* *Clothilla pulsatoria* (Linn.), known in England as the "death-watch," from the ticking sound made by it, and *Psocus domesticus* Burm., also infest collections of natural history. In Hagen's *Neuroptera of North America*, of the sixteen species of *Psocus* described, nine are credited to the State of New York. Later studies have changed the generic references of several of these, and other species of Psoci occurring in New York have since been described.

Remedies.

When the apple-leaf Bucculatrix occurs abundantly upon young trees, if the trees are given a sudden jar, when the caterpillars have about attained their growth, at some time during the months of May and September, large numbers of the caterpillars which drop from the leaves and hang suspended by their silken threads can be swept upon a broom and crushed, or scalded in hot water. The application of kerosene oil, diluted with hot soap-suds, to the cocoons, by means of a force-pump and spray-machine or atomizer, has been recommended. If applied during the month of March or April, when the circulation of the sap has commenced, the chance of injury to the tree will be less. Linseed oil might also be employed, but would not so readily penetrate the cocoons to the inclosed pupæ, which must be reached in order to prove effectual.

If the limited number of the cocoons admit of their removal by scraping them from the twigs, this would be the better method to employ. Their white color at once discloses their presence, and serves to show when their complete removal has been effected.

Mr. Chambers, in a late communication to the American Entomologist (*loc. cit.*), expresses his belief that the destruction of the pupæ within their cocoons upon infested apple-trees, by spraying them with oil, may not place the insect within our control, for the following reason: He had found as many as twenty of its cocoons in a cluster on elder (*Sambucus*), at least fifty yards distant from the nearest apple-tree, and there were no indications, or was it probable, that the larvæ ever fed upon the leaves of the elder. The species, therefore, shared the habit not uncommon in Bucculatrix larvæ of deserting their natural food-plant when mature, and wandering elsewhere to spin their cocoons. Mr. Chambers suspects that *Bucculatrix thuiella*, found by Dr. Packard on *Thuja*, may only have wandered thither from some other food-plant, as it was not observed as depredating on the cedar.†

*Hubbard: in *American Entomologist*, iii, 1880, p. 39.

†*American Naturalist*, v, p. 149; *American Entomologist*, iii, 1880, p. 50.

Coleophora malivorella Riley.

The Apple-tree case-bearer.

(Ord. LEPIDOPTERA: Fam. TINEIDÆ.)

RILEY: in Ann. Rept. Commis. Agricul. for 1878, (1879), pp. 208, 253, 254, pl. vii, f. 1 (description, natural history, etc.): also, the same in Rept. of the Entomol., Aug. 1879, pp. 3, 48, 49, pl. vii, f. 1.

CHAMBERS: in Bull. U. S. G.-G. Surv. Terr., iv, 1878, p. 93 (as *C. multipulvella, auct.* Walsingham).

LINTNER: in 39th Ann. Rept. N. Y. St. Agricul. Soc. for 1879, (1880), p. 52, figs. *a–d* (history, etc.); in Count. Gent., July 6, 1882, xlvii. p. 533.

BARNARD: in Proc. Amer. Assoc. Adv. Sci., xxviii, 1880, p. 477, pl. "Insect Habits," f. 8 (case not identified).

WALSINGHAM: in Trans. Amer. Ent. Soc., x, 1882, p. 194 (synonymy, etc.).

This species has recently proved quite destructive to apple-trees in a portion of Pennsylvania, adjoining the western boundary of New York, where it has entirely destroyed the leaves of many trees. The first public notice that we have of it is that of Professor Riley, in his Annual Report as Entomologist of the U. S. Department of Agriculture, in 1879, where its history is given, partly from actual observation, and in part drawn from the known habits of a closely allied European species, *C. anatipennella.*

The Several Stages of the Insect.

The new depredator is the larva of a small moth belonging to the family of *Tineidæ*. The caterpillar, shown at *b* in the accompanying figure (its natural size indicated by the hair-line beside it), is about one-sixth of an inch in length, of a yellowish color, with a large black head, its legs yellow and tipped with black, and its last two segments covered with brown granulations and bearing some long hairs. The moth represented at *d* (three times the natural size) is about one-half of an inch in expanse: its pointed and long-fringed wings are mouse-colored, with some white scales near the base. The tip of the abdomen and the legs are white. The pupal

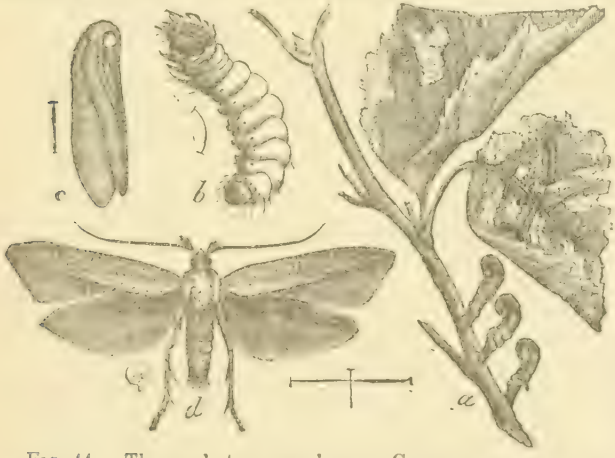

FIG. 44.—The apple-tree case-bearer, COLEOPHORA MALIVORELLA: *a*, *a*, the cases containing the larvæ, shown in natural size; *b*, larva, enlarged; *c*, pupa, enlarged; *d*, the moth, enlarged. (Riley).

form is seen at *c*. At *a*, *a*, *a*, are shown the peculiar pistol-shaped cases, sheltering the larvæ, composed of silk, bits of leaves and excremental matter, which the caterpillars construct for their protection, and which they carry about with them during their period of activity, serving also for a winter retreat and for pupation. The smaller cases upon the leaves show, in connection, the character of the larval injuries at different stages of growth.

The following detailed account of the caterpillar and of the moth is that of the original description: —

Description of the Larva and Moth.

Larva — Length 4 mm. Color pale yellowish, often with faint roseate hue. Head retractile, large, black, granulated, and with a few rather long hairs at the sides; median suture white; antennæ 4-jointed, yellow, with the base of each joint white, the two basal joints equal in length, the third and fourth each one-half as long and more slender; a long bristle arises from the apex of the second joint. Prolegs brown with the tips whitish; thoracic legs yellowish with the claws blackish. Thoracic joints each with a blackish, strongly granulate chitinous patch at the lateral projection, the mesothoracic joint having also two narrow black transverse dorsal spots posteriorly, and a subdorsal yellowish spot of a similar nature. The two anal joints are covered with brown granulations and furnished with rather long hairs.

Imago — Female: — Expanse 14 mm. Head, face, and palpi white. Antennæ white annulated with fuscous, basal joint with a long tuft of intermingled white and fuscous scales reaching to the sixth joint. Primaries fuscous (mouse-color more nearly), with many white scales at the base, especially behind the median vein. Cilia fuscous; secondaries fuscous; thorax white, with a few fuscous scales. Abdomen with the anal tuft whitish. Legs white with a ring of fuscous at the base of each tarsal joint.

Male: — Expanse 12.5 mm. Differs from the female in the head, face, and palpi being fuliginous, and in having no tuft on the basal antennal joint; also, in being somewhat darker, the wings usually lacking the white basal scales, and the legs being more grayish.

Natural History of the Insect.

The history of the insect, as given in the report above cited, is as follows: The parent moths appear abroad during the latter part of July, and deposit their eggs on the under side of the apple leaves. The larvæ hatch in September, and commence to feed upon the under surface of the leaves. They are of the kind known as case-bearers, as they construct for their protection and occupation cases composed of silk, bits of leaves, and their excrementa, which they carry about with them, thrusting out their anterior segments for the purpose of feeding. The cases have a peculiar curve at their posterior end, like the handle of a pistol. At the advent of winter they retreat within their cases, which they attach to the twig, and the less than half-grown caterpillar passes the winter in this condition. At this stage, the cases

measure about one-tenth of an inch in length, and are more curved at their end than the mature form. From their small size and a color almost the same as that of the bark to which they are attached, they are not readily noticed.

In early spring, the larvæ awake from their winter sleep, and transport themselves to the swelling buds, upon which they commence to feed. The leaves, as they develop, are attacked in turn, and where the insect abounds, they are rapidly devoured. The younger trees show branches which have been entirely defoliated, while others are left leafless from the destruction of the buds. The young fruit is also eaten into, until barely a shell of it is left.

About the middle of June, the larvæ attain their growth, when they cease feeding, and fasten their cases to the twigs, and, within them, transform to the pupal state. Their pupation lasts for about three weeks, when the perfect insects emerge, and deposit their eggs upon the leaves, as before stated.

Its Operations in an Orchard.

The operations of this insect pest were first noticed in 1877, in the orchard of Mr. William Fairweather, of the Densmore Apple Farm, at McLane, Erie county, Penn. In that year he reports that of the 8,000 trees in his orchard, there was scarcely one which was not more or less affected. On some of the smaller trees, the leaves were completely skeletonized. The following year, the ravages were still more destructive, and large numbers of trees were rendered nearly leafless. In 1879, as I learned from Mr. Fairweather, the injuries were less than in the two preceding years, but from the number of cases observed upon his trees at the time of writing (Jan. 17, 1880), he greatly feared that they would again be in full force the coming summer, and extend their operations "to an extent sickening to think of." A tree from which he sent me some twigs thickly studded with the cases, had, he thought, enough of the insects upon it to eat up every leaf as it appeared.

From a communication in relation to this insect subsequently received from Mr. Fairweather, he informed me that the fears above expressed were not realized. Its ravages were not increasing, and during the years 1880 and 1881, its depredations in his orchard had not been serious.

Attack of a Chalcid Parasite.

Mr. Fairweather ascribes the diminution of the injuries to the beneficial results of an attack which had been made upon the pest by a small parasite, examples of which he had hatched from some pupæ of the moths inclosed in a glass jar, and which he found to be "a small and lively insect like a black ant, but less in size, and with wings."

This parasite is probably the one referred to by Professor Riley, as "a minute Chalcid fly, which has increased to such an extent since the ravages of the Coleophora became apparent on Mr. Fairweather's place, that it bids fair to render additional remedies unnecessary. The specimens sent in 1877 were not parasitized; those sent in 1878 were about half of them affected, and of twenty-four specimens received in March, 1879, seventeen [over seventy per cent] had been destroyed by this little fly." The species has not, so far as I know, been determined.

It is somewhat strange that this insect does not appear to have extended its depredations to any of the orchards in the immediate neighborhood of the Densmore Apple Farm.*

Other Case-bearers.

In vol. xxviii of the *Proceedings of the American Association for the Advancement of Science* (1880), Professor W. S. Barnard has figured what is, without much doubt, the case of this insect, which had been found by him upon chestnut, near Ithaca, to which it may have strayed from the apple, after the habit of *Bucculatrix pomifoliella*. In the same paper, the singular cases of several other *Coleophora* are described, one of which, occurring on a species of rush growing on woody knolls, is illustrated and its interesting peculiarities described at length. Another case, which had appeared late in autumn very plentifully on some of the apple-trees about Ithaca, of which the insect hibernates on the lower side of the branches in a small, flat, obovate purse which is pendant to the bark by a small mass of silk, is the *Aspidisca splendoriferella* Clem., or the Resplendent shield-bearer. An extended account and full illustration of this species, by Professor Comstock, may be found in the *Report of the Commissioner of Agriculture* for the year 1879 (pp. 210–213, pl. 2, f. 2).

Remedies.

Whenever, from absence of parasitism, or other cause, this little pest (called by one of my correspondents, in consideration of its minute size and its serious ravages, the "*multum in parvo*") becomes injuriously numerous, it may doubtless be controlled by the use of Paris green or London purple. The former, Mr. Fairweather, thinks too expensive in cost of material and labor of application for employment in an orchard of the extent of his, numbering six thousand trees; but although the protection of large orchards necessarily involves large expenditures for material and labor, yet it should be borne in mind, that the percentage of cost to each tree protected is no greater when ap-

*As I learn from examples sent to me by Mr. C. E. Cook, of South Byron, Genesee county, N. Y., the insect, at the present time (June 20, 1882), is infesting the apple-trees of his orchards, to quite an injurious extent. He had not detected its presence previous to the present season.

plied to ten than to a thousand, and if it pays to employ remedial measures on a small scale, it will, at the least, prove equally profitable on a larger scale.

London purple would probably be quite as valuable in protecting large orchards as the more costly Paris green. Its much less cost would permit of its more thorough and frequent use, and it seems also to possess the additional recommendation of being absorbed to a greater degree by the leaves. It could be conveniently applied by means of the forcing pump (illustrated on pages 29 and 30), throwing the liquid from a barrel placed on a wagon and drawn through the orchard. The efficacy of this material in preventing the ravages of the Codling moth of the apple has been tested by Professor A. J. Cook, and its use for the purpose was strongly recommended by him, and sustained against adverse criticisms, at the Cincinnati meeting of the American Association for the Advancement of Science. Young apple-trees which had been treated by this method had given fine crops of sound fruit, which had been freely eaten by himself and family without any injurious results. The quantity of London purple used was a tablespoonful to a pail of water, which was found to answer for three trees. In using it against the case-bearer, a large amount of the liquid should be thrown upon the tree, as it would need to be very generally distributed in order to reach all the buds or the foliage.

As a general rule, the best time to attack our injurious insects is when they are just from the egg, and so delicate that they may be easily destroyed. The young caterpillars of the case-bearer emerge from the eggs during the month of September. It would not be prudent to apply the poison at this time, except to trees bearing early apples from which the fruit had been gathered. Even to these, it would require a large amount of liquid to reach all the leaves of the tree upon which the young larvæ might be feeding. Beyond this, the feeding done by them before retiring, less than half-grown, within their cases for hibernation, would not be of any appreciable injury. The proper time, therefore, to use the poison is when the larvæ have awakened from their winter's sleep, and are resorting to the buds to resume their feeding. This can easily be ascertained by observation, and careful inspection of the infested trees should be made during the first warm days in early spring, as soon as the first insects are seen upon the wing. If at this time, all the expanding buds be sprayed with the liquid, and the operation be repeated two or three times at intervals of a week or after rains, during the opening of the buds and the unfolding of the leaves, very few of the case-bearers will be spared to continue their ravages, and to complete their transformation to the perfect moth, laden with eggs for the perpetuation of the pest in another brood.

ON SOME SPECIES OF ANTHOMYIIDÆ.

The opportunity of observing, during the past summer, the several stages and transformations of some species of *Anthomyiidæ* which had not been known to us in this country before, has led me to an examination of the histories of the allied species; and as some of them merit special consideration from their depredations upon important crops, and one, from the material aid rendered by it in the destruction of the Rocky Mountain locust, it is believed that a notice of the several species, presenting the latest discoveries in relation to their history, their present accepted nomenclature, and the best means of preventing their injuries, may prove convenient for reference, and of service to the student and agriculturist. Some general remarks respecting the family to which they belong and their classification may serve as a fitting introduction to specific details.

Habits of the Anthomyiidæ.

The *Anthomyiidæ* have been so named (from *anthos*, flower, and *muia*, fly) from their habit of frequenting various flowers, particularly those of the *Umbelliferæ* and *Compositæ*; but as there is another group of flies, known as the *Syrphidæ* — prettily variegated in yellow and black, and many of them bearing resemblance to bees, wasps and hornets, which are pre-eminently flower visitors for feeding on their pollen or nectar — the designation of "flower-flies" may properly be reserved for them. The Anthomyians, in addition to their love of flowers, have also their seasons for idle sporting, and large companies are at times to be seen indulging in aerial dances, after the manner of some of the gnats. Their larvæ (naked, footless forms, often spoken of as "maggots") feed usually on living vegetable matter, as the roots of plants and the inner tissue of leaves, but some of the species find their nourishment in decaying vegetable matter and in manure. In the genus *Homalomyia*, where the species live in wet, decomposing vegetable and animal matter, that their respiration may be the better maintained in such situations, they are provided, in the place of the ordinary spiracles or breathing-pores, with lateral branchiæ or gills, which, as in the fishes, permit the air to be extracted from the surrounding fluids. Some of the species of this genus, as *Homalomyia canicularis*, and the "privy-fly," *H. scalaris*, which occur in both Europe and North America, are recorded as having been, in a number of instances and sometimes in large numbers, discharged from the human

stomach and intestines, where they may have been introduced in incautiously eating decaying fruit and vegetables. A list of one hundred and eight instances in which insect forms have been discharged from the human body, was published forty years ago;* among these were several of *Homalomyia*. A list of twenty such discharges from the urethra has been collected and published by Dr. Hagen.† but the reliability of the testimony upon which most of them rest is questioned by the author of the paper, and it is thought that not one had been proved by indubitable evidence.

Characteristic Features of the Anthomyiidæ.

Structurally the Anthomians are closely allied to the typical species of the family of *Muscida*, which embraces our common house-fly, the meat-fly, the blow-fly, etc., from which family they were separated by Meigen, in 1838. An obvious difference between the two is to be found in the neuration. Fig. 45 represents the neuration of the *Anthomyiidæ*, as it occurs in the wings of the Onion-fly, *Phorbia cepurum*. The veins and cells are indicated by numerals and letters, and the terminology given below is that of Osten Sacken. The venation of the

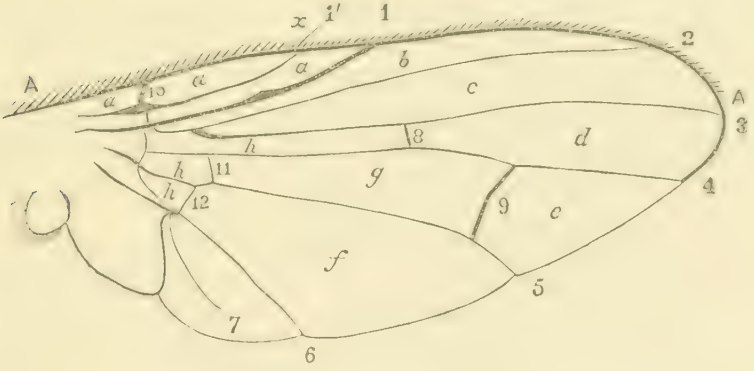

Fig. 45.—Enlarged wing of the onion-fly, Phorbia cepurum *Meig.*—A A, costal vein; 1', auxiliary vein; 1, 2, 3, 4, 5 and 6, first, second, third, fourth, fifth and sixth longitudinal veins; 7, axillary vein; 8, middle transverse vein; 9, hinder transverse vein; 10, transverse shoulder vein; 11, anterior basal transverse vein; 12, posterior basal transverse vein; *a*, *a*, *a*, first, second and third costal cells; *b*, marginal cell; *c*, submarginal cell; *d*, *e*, *f*, first, second and third posterior cells; *g*, discal cell; *h*, *h*, *h*, first (the large upper), second and third basal cells; *i*, anal or axillary corner of the wing; *j*, alar appendage (alula); *k*, axillary incision. (For the last three, see Fig. 46.)

*On the Insects and their Larvæ occasionally found in the Human Body. By Rev. F. W. Hope. *Trans. Entomolog. Soc., London*, ii, 1840, p. 256.

†On Larvæ of Insects Discharged through the Urethra. By Dr. H. A. Hagen. *Proc. Bost. Soc. Nat. Hist.*, xx, 1878, pp. 107–118.

Muscidæ is shown in Fig. 46, drawn from *Calliphora vomitoria*, the common blue meat-fly of butcher's-stalls and occasionally of our houses. The references to veins and cells are the same as in the preceding figure. From a comparison of the two it will be seen that they differ mainly in the shape of the first posterior cell, *d*, which in the *Anthomyiidæ* is quite open, instead of being nearly closed at the

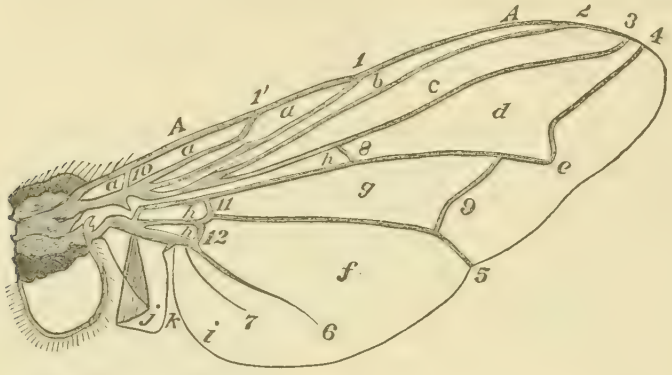

Fig. 46.—Enlarged wing of the Blue meat-fly, Calliphora vomitoria: the veins and cells are numbered and lettered as in Fig. 45.

wing-margin, as in *Muscidæ*, by the sudden bending up of the fourth longitudinal vein when near the margin, and running obliquely upward to very near the termination of vein 3.

The *Anthomyiidæ* are further distinguished by a transverse suture (impressed line) crossing the thorax, and by their tegulæ (the covering scales of the spiracles of the hinder thorax) being rather well-developed, although frequently not very large in size.

The Anthomyiidæ an Extensive Family.

The family is a numerous one. Baron Osten Sacken, in his Catalogue,* records one hundred and thirty-nine North American species (including above fifty of Walker's unrecognized species), belonging to twenty genera. Later, Mr. R. H. Meade, of England, who has been making special study of the family, has enumerated one hundred and forty-one species, in nineteen genera, from material sent to him from the Museum of Comparative Zoölogy at Cambridge, Mass.,† which, with others in the Museum not seen by him, and those to be noticed in the present report, gives, so far as recognized at the present, one hundred and thirty-six North American *Anthomyiidæ*. Of these, no less than thirty-five species are accepted as identical with European ones.

**Catalogue of the Diptera of North America.* By C. R. Osten Sacken, Washington, 1878, 8vo, p. 276.

†List of North American Anthomyiidæ, examined by R. H. Meade, Esq., Bradford, England. By Dr. H. A. Hagen.—*Canad. Entomol.*, xiii, pp. 43–51, 1881.

The New York Species of the Family.

Five species of the interesting genus of *Homalomyia* Bouché, to which reference has been made (four included in the Meade list) occur in the State of New York. The first two mentioned are the more common. The first, from its being so frequently found in houses, has been called the "lesser house-fly," *Musca domestica minor* De Geer; the second has received its common name of the "privy-fly" from its larva occurring in human excrement, particularly in the contents of old vaults. The larvæ of this genus are not rounded forms as in *Anthomyia*, but have flattened bodies, as indicated by the generic name, and also in their popular name of "flat-flies." An excellent paper upon these forms may be found in the *American Entomologist*, vol. ii, pp. 137–141, from the pen of Mr. Walsh, published after his death. The species are the following (the Meade numbers are prefixed to those seen by him) :—

44. *Homalomyia canicularis* (Linn.). New York and Mass.
45. *H.* *scalaris* (Fabr.). N. Y., Penn., Mass., Me.
46. *H.* *prostrata* (Rossi). N. Y., Mass.
50. *H.* sp. indet. N. Y., Greenland.
— *H.* *tetracantha* Loew. Middle States.

Of the genus *Anthomyia* Meig., the larvæ of which are naked, not having the branching lateral appendages of the preceding genus, the following New York species are recorded:—

57. *Anthomyia latitarsus* Slaeg. and Zett. N. Y. and N. Hamp.
59. *A.* sp. indet. Similar to *A. pluvialis*, of Europe.
— *A.* *brassicæ* Bouché. Perhaps same as *A. ruficeps* Meig.
— *A.* *ceparum* Bouché.* Same as *A. antiqua* Meig., auct. Schiner.
— *A.* *raphani* Harris. Perhaps same as *A. radicum* Linn.
— *A.* *similis* (Fitch). Similar to *Hylemyia deceptiva* Fitch.

In *Hylemyia* Desv., of the fourteen species indicated, four are from New York, viz.:—

60. *Hylemyia* sp.? N. Y., N. J., and British America: apparently abundant.
61. *H.* sp.? N. Y., Conn., and N Hampshire.
62. *H.* *deceptiva* Fitch. N. Y., Hudson's Bay, and Arctic America.
63. *H.* *tarsata* Sik. N. Y. and Ill. Perhaps *A. alcathoe* Walk.
64. *H.* sp.?: also 65 and 67, sp. indetermined. Two other species are from Canada and New Hampshire and are probably to be found in New York.

Twenty-two species are referred to the genus *Chortophila*, of which nine are credited to New York, and eight additional ones from localities so near, as Canada, Massachusetts and Connecticut, that they may be presumed to occur also in New York. Many of the species are small and some are known to have an extensive distribution, ranging from the District of Columbia to the Arctic regions.

*Since the publication of this paper, the species has been removed to the genus *Phorbia*, as will be noticed hereafter.

In other genera of the family, fifteen species are enumerated from the State of New York: in all, forty-one species, distributed in eleven genera. Many others are undoubtedly to be discovered, as additional attention shall be paid to them. They are extremely difficult of study, from their close resemblance to one another. The females of several of the species are so much alike that they can scarcely be determined unless their males occur with them.*

Phorbia ceparum (Meigen).†

The Onion-fly.

Ord. DIPTERA: Fam. ANTHOMYIIDÆ.

Bouché: Naturgeschichte der Insecten, 1834, p. 73.

Westwood: in Loudon's Mag. Nat. Hist., vii, 1834, p. 425; in Gardener's Mag., xiii, June, 1837, p. 241; Introduc. Class. Ins., ii, 1840, p. 570, f. 132, 3–6.

Kollar: Ins. Inj. to Gardeners, etc., 1840, pp. 157–9 and figures.

Harris: Rept. Ins. Mass., 1841, p. 415; Treat. Ins. New Eng., 1852, p. 495; Ins. Inj. Veg., 1862, p. 617, f. 272 (habits, but another fly described).

Curtis: in Gardener's Chronicle, 1841, p. 396 and figures: Farm Insects, 1860, p. 145 (mention).

Kirby-Spence: Introduc. Entomol., 1846, p. 141 (brief mention).

Glover: in Rept. Commis. Agricul. for 1864, p. 563 (remedies); Rept. for 1867, p. 73 (mention); Rept. for 1872, p. 133 (history and remedies); MS. Notes Journ.— Entomolog. Index, 1877, p. 5 (references).

Walsh: in Pract. Entomol., i, 1865, p. 20 (remedy); Id., ii, 1867, p. 64 (brief notice).

Slade: in Rept. Commis. Agricul. for 1865, p. 238 (with notice of onion and culture).

Fitch: in Ann. Reg. Rur. Aff., v, 1867, p. 91; Eleventh Rept. Ins. N. Y., in Trans. N. Y. St. Agricul. Soc. for 1866, xxvi, 1877, pp. 487–494, figs. 1–5 (habits, transformations and remedies).

Boisduval: Entomol. Hortic., 1867, p. 611.

Packard: Guide Study Ins., 1869, p. 411, f. 332 (larva and imago); Second Rept. Ins. Mass., 1872, p. 8; in Hayden's Ninth Rept. G.-G. Surv. Terr., 1877, pp. 740–742, pl. 67, f. 1 (transformations and remedies).

Dodge: in Rept. Commis. Agricul. for 1869, pp. 224–226 (natural history and remedies).

Riley: in Amer. Entomol., ii. 1870, p. 110, f. 72 (an imported insect).

Ormerod: Rept. Inj. Ins. for 1877, p. 7; Id. for 1878, p. 7; Id. for 1879, p. 12; Id. for 1880, pp. 15–18; Id. for 1881, pp. 35–38; Manual Inj. Ins., [1881], pp. 123–129 and figures (habits, history, preventives and remedies).

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*The reverse of this is seen among some of the Hymenoptera. "In the Vespidæ, there exist a number of species of which the males resemble one another so far as not to be distinguishable. * * * There is a whole category of species of the genus *Elis*, of which the females offer differences the most extreme, but of which the males are so confounded that they cannot be distinguished from each other (Dr. de Saussure, *Synopsis of American Wasps*, 1875, p. xviii).

‡The *Anthomyia ceparum* of all the following citations except the last.

OST. SACKEN: Cat. Dipt. N. Amer., 1878, p. 168 (references), p. 258 (note).
BETHUNE: in Ann. Rept. Ent. Soc. Ontario for 1880, (1881), p. 43.
MEADE: in Entomol. Month. Mag., xix, 1883, pp. 213, 218 (as *Phorbia cepetorum*).

The onion-fly has long been known to interfere seriously with the cultivation of onions. Its ravages had been noticed and recorded both in this country and in Europe, long before Bouché, in the year 1834, described it as infesting onions, and gave to it the scientific name of *Anthomyia ceparum*, which it has since borne up to the present time, and by which it has so often been presented to public notice by entomological writers.* It is not known when it was introduced in this country, but it may easily have been brought over at any time, either as larvæ feeding during the voyage, or as pupæ, since its pupal transformation often takes place within the plant. It is rather a local species, being very destructive in some localities, and almost unknown in others. It also, like many other of our injurious insects, has its periods of unusual abundance over a broad extent of territory. Thus it is recorded as having been quite destructive in the Eastern and Middle States in 1854 and again in 1863.

Its Natural History.

There are successive broods throughout the season. The first attack is made as soon as the young seedlings are an inch or two above the ground. The flies are attracted to the plants, and deposit their eggs upon the lower part of the leaves, either among them at their base, or, as frequently, along the edge of the lower leaf or sheath as shown in Fig. 49. Seldom more than a half dozen eggs are deposited on a single plant.

The Eggs. — The eggs are white and smooth, elongate-oval in form, and of a size which admits of their being readily seen by the eye, being four-hundredths of an inch long and about one-hundredth broad. In Fig. 47 at *a* and *b* they are shown in their natural size and in enlargement. They usually hatch within a week, the time required varying with the different broods and with the temperature of the season.

The Larvæ.— The young larva, upon leaving the egg, burrows downward within the sheath, leaving behind it a discolored streak to mark its passage. It penetrates the cylindrical root, of which it consumes the interior with the exception of the outer skin. At a later stage of growth of the plant when the bulb has commenced to form, several of the larvæ may be found feeding in company. When

*According to Professor J. O. Westwood, Kirby and Spence were the first to apply the specific name to this insect. Reference is made by him (*Mag. Nat. Hist.*, vii, p. 425), to "*Scatophaga ceparum* K. and S., i, 190." This may have been in the first edition of the *Introduction to Entomology*, to which I have not been able to refer. Probably no description accompanied the name.

the bulb is consumed, they desert the plant for another, and still others in succession, as a dozen or more young onions would be needed to furnish the requisite amount of food for maturing a half-dozen of the larvæ.

The larva when full grown, shown at *c*, in the accompanying figure and at *d*, in enlargement, is nearly one-third of an inch in length. It is glossy, dull white, smooth, naked, of an elongate-conical form, with its anterior end capable of being extended, while feeding, into an acute point. At the extreme end, the two black hooks which form the cutting organs of the mouth show through the skin as a short black stripe. Near the head, the projecting breathing organs are visible. A stripe seen along the middle of its back is the alimentary vessel with its contained substance. The hinder end of the body is obliquely truncated, and on its flat surface are two small elevated brown points (the spiracles or breathing tubes of this extremity of the body), and on the margin are eight small projections, like teeth, of which the lower two are the larger. Slightly in advance of these latter are two small processes which appear to be of service to the larva in its travels. Some prominent folds — one on the under side of each segment — are also aids in locomotion.

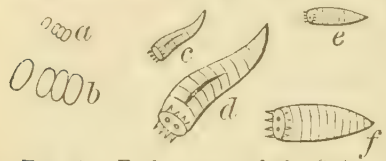

FIG. 47.—Early stages of the Onion-fly: *a*, eggs, natural size, *b*, enlarged; *c*, *d*, the larva, natural size and enlarged; *e*, *f*, the puparium natural size and enlarged. (After Fitch.)

Pupation.

In about two weeks in summer, the larva has attained its growth, and is in readiness for its pupation. In a number of recorded instances it has assumed this stage within the onion, but it usually withdraws itself into the surrounding ground. It has soon contracted in length and become of an oval form, moderately pointed at its anterior end, and somewhat flattened at the other, where projections resembling those of the larva may be seen. The skin has hardened and has changed to a chestnut-brown color, and in this condition resembles some of the pupal forms. It is not the pupa, however, but only its envelope or case protecting the true pupa, which, upon breaking open the outer covering a few days after its formation, would be found as a soft and white body showing the jointed abdomen, with the wings and legs of the future fly appressed to its surface. This case, which shelters the inclosed pupa like the cocoon of a moth, is known as a puparium.* It is shown in Fig. 47, at *e* in its natural size, and at *f* enlarged.

*It is described by Westwood as "of a chestnut color, having its posterior end blackish with the extremity red, and two large black spots observed in the larva; the oral tentacula are also observable at the other end, they being somewhat exserted." (*Mag. Nat. Hist.*, vii, p. 428.)

The pupa state ordinarily continues for about a fortnight in summer when the front end of the puparium is broken open, and the fly emerges and escapes from the ground. The general appearance of the fly is shown in Fig. 48 (after Fitch), and in Fig. 45, *ante*, page 169, a more accurate view of the wing is given, in enlargement. The last brood of larvæ pass the winter in the pupa state, and the flies emerge in early June, or about the time when the young onions are in readiness to receive their eggs.

FIG. 48.—The Onion-fly, PHORBIA CEPARUM, Meigen, enlarged.

Commencement and Progress of an Attack.

The first indications of an attack by the larvæ upon young onions, the method of their procedure, and the progress of the injury, are so well presented by Dr. Fitch (Eleventh Report on the Insects of the State of New York, in *Trans. N. Y. State Agricul. Soc.*, for 1866, p. 489) that we give it here:—

"The first indication which we have that our onion bed is invaded by this enemy, we discover that two or three of the young plants are wilted down and lying on the surface of the ground, perhaps changed to a yellow color, and the plant next in the row to those prostrate ones probably has its lower or outer leaf similarly wilted and prostrate, although it is green and shows no wound or other indication of disease, and the other leaves of this plant are erect, and to the eye appear perfectly healthy; but on feeling them we find that they are soft and flaccid, not firm and substantial, like those of the unaffected plants. Thus by the feeling of the leaves we readily detect those plants which have worms in their roots.

FIG. 49.—Young onion attacked by the onion-worm (after Fitch).

"On carefully digging up and examining the affected plant, if it is young and the roots small and cylindrical, we commonly find it completely cut asunder, as represented in Fig. 49, only the thin outer skin remaining, whereby the slightest pull upon the top draws it up out of the ground. Later in the season, when the round bulb is beginning to be formed, as in Fig. 50, we find a hole perforated in its side, opening into a cavity in the interior, and the earth around this perforation is wet and slimy, forming a mass of filthy mud in which those worms are lying which are not engaged in feeding. And by this interior cavity the central leaves of the plant are severed from their connection

with the fibrous rootlets, as shown in the figure, whereby it is now these central and not the outer leaves which first turn yellow and die; and all the upper portion of the root becomes soft and putrid, while the bottom part, continuing to be nourished by the fibrous rootlets, remains sound, and the worms now crowd into this part to feed, whereby it sometimes presents a wonderful appearance, being thronged with worms wedged together side by side in a compact mass, all with their heads downward, eagerly consuming the last remains of food there is there, and only the rounded hind ends of their bodies exposed to view, these forming an even surface similar to the cobble-stones of a street pavement, as represented in Fig. 51."

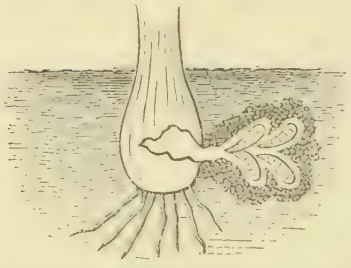

FIG. 50.—Onion bulb with the larvæ in the ground adjacent (after Fitch).

FIG. 51.—Base of an onion crowded with feeding larvæ (after Fitch).

Although the onion, in all its stages and in its different varieties, is subject to attack, yet the fly occasionally selects a limited locality or even a particular onion for the deposit of its eggs. Dr. Fitch has given a remarkable instance which illustrates this selection: "An escallion, a month after it was set out, having wilted and turned yellow, the whole of its root was found to be a soft putrid mass of a most offensive smell, everywhere thronged with these maggots of all sizes, some of them newly hatched and no larger than the eggs from which they came, others full grown, and others changed to pupæ and lying in the wet dirt in contact with the root. I judged that there was upward of two hundred of these maggots in this one onion, which was little more than half an inch in thickness. And though there was now no sustenance remaining for their nourishment, unless they fed upon the putrid as well as upon the sound substance of the onion, every crevice above ground, around the bases of the leaves, was occupied with eggs to the number of about fifty, and many empty shells from which worms had recently issued. It was a mystery to me why such a multitude of worms should occur in this particular onion, and why flies continued to deposit their eggs upon it, when it was already so overstocked as to furnish no food for their young."

Insect Enemies.

No parasite is known to prey upon the onion-fly. In Europe there is a small four-winged Ichneumon fly, *Alysia manducator* Panzer, which destroys its pupa. It has not been detected in this country, but the genus is represented by at least three determined species* of

Proc. Entomol. Soc. Phila., i, p. 211, 1862.

which the habits are as yet unknown, and by several undescribed species that are to be found in our collections.

It is believed that the larvæ of the Golden-eyed flies, of the genus *Chrysopa*, are of service in destroying the eggs of the onion-fly, as they are known to devour eagerly the contents of similar eggs, and their own eggs attached to their hair-like pedicel, have been frequently seen upon the lower part of onion plants convenient to the eggs of the fly.

Preventives of Attack.

Many methods have been recommended for use against this pest. Several of them will be given, for often it is only by trial of various methods that one may be selected which will prove efficacious in a particular locality. An application which will be entirely successful under one condition of soil may be of no service whatever where the conditions are quite different; and the convenience for obtaining the materials to be employed may also vary greatly with the locality.

Kollar, in his *Treatise on Insects Injurious to Gardeners, Foresters and Farmers*, recommends as a preventive strewing the onion-bed with powdered charcoal, leaving small portions without the application, where the flies may deposit their eggs, and the infested onions subsequently taken up and destroyed by burning or deep burying.

Dr. Fitch suggests that instead of sowing onion seed in rows, where the young seedlings grown in contact, give every facility for the larvæ to pass from one to another, that they should be grown in hills of only three or four seedlings and among other vegetables, so that when the young larvæ have consumed one hill, they would be unable to travel through the soil the distance required to find another, and would, therefore, die before maturing.

Scattering dry, unleached ashes over the beds as soon as the plants are up, while they are wet with dew or from rain, and at intervals thereafter of a week throughout the month of June, has been found serviceable in preventing the deposit of the eggs upon the plants.

Miss Ormerod, of Dunster Lodge, near Isleworth, England, who, during the past few years, has published several quite valuable Annual Reports of "Notes and Observations on Injurious Insects," has given in each, such methods for the prevention of the attacks of this fly as have been tested and have yielded the best results. Among them are the following:—

Pulverized gas-lime scattered among the onions was found to act well in keeping off the insect.

Watering with the liquid from pig-styes, collected in a tank provided for the purpose, was found to answer still better.

Deep cultivation in autumn, with a good manuring and sowing in drills on a firm, well-trodden surface in spring, insured a good crop, free from the attack of the maggot. In a bed, one-half of which had been prepared in the above manner, and the remaining half only trenched but not manured, the plants in the former were uninjured, but on the latter feeble and attacked by the maggot.

A correspondent of Miss Ormerod presents the following experience: "I find the best preventive in our light soil is to manure well with well-made manure, principally cow manure. We work the ground deeply and trench if need be. After lying exposed to the frost for some time, the ground is pulverized (with a steel fork) on the surface without turning up the manure, then trodden down well previous to sowing, which we do as early as possible in March, providing the ground is in good condition. We sow in lines a foot apart. After covering in the seed, we pass a heavy iron roller a few times over the ground to firm it well. We sow thinly, so that we seldom require to thin the plants. In this way we never fail to have excellent crops of onions, although the garden has been very subject to attacks from onion-fly; and there are many gardens in the neighborhood where the fly has all its own way with the onion crops."

Another correspondent makes use of "hen manure which had been well turned during the winter and covered with soil to retain the ammonia." In place of the roller, the soil is well trodden with the feet and raked over. The trampling of the feet makes it quite hard, and it is considered to do good by preventing progress of the larva. Another person recommends horse manure not over fermented for use on heavy damp soils.

A writer in the *Gardener's Chronicle and Agricultural Gazette* (vol. xiii, 1853, p. 197) states that a simple preventive of attack of the fly, satisfactorily tested by him, is dry soot, dusted over the soil lightly once a fortnight from the time of sowing until all danger is past.

Remedies for Attack.

When an onion-bed has been attacked by the fly, which may readily be known by the leaves wilting and turning yellow at the tip, every onion giving indication of the attack should be taken up at once and destroyed by burning or otherwise. If this be done promptly and thoroughly it will terminate the attack. The onions should not be *pulled up*, but carefully *lifted* by means of a broad-bladed knife, so that the entire bulb with the larvæ within it, may be removed. If simply drawn by hand, the stem, which often is only held in place by its thin skin, will separate from the decayed base, which, with the contained larvæ, will be left behind and no good whatever accomplished.

Water nearly at the boiling temperature poured from a tea-kettle along the rows of onions which have attained considerable size, has been found to kill the larvæ without injury to the plants. It is also stated that watering with strong soap-suds, when the attack is first noticed, has entirely arrested it.

Miss Ormerod believes that the most successful remedy is to be found in a proper use of paraffin oil. Care is required lest it should be used in excess, when it will injure the plants. It may probably be applied with greater safety by saturating sand with the oil to be sown among the onions, and afterward sprinkled from the rose of a watering pot. In one instance reported, a pint (English measure) of the oil was put in two gallons of water, and with it the onions planted in rows were watered through the nozzle of a watering-pot. In another, a good glassful of oil was mixed with about six gallons of water and thrown in a spray over the beds: two or three applications ended the attack. To test the efficacy of paraffin oil in the destruction of the larvæ, a number of them were placed in a flower-pot in soil with young onions. Some days thereafter three drops of the oil were introduced in the pot, and after twenty-four hours, upon examination, all the larvæ, except two, were dead.

The American Fly Compared with the European.

The *Anthomyia cepurum* of Authors (the name by which the onion-fly has long been known) has for some time been regarded as probably identical with the *Anthomyia antiqua* of Meigen, having been given as a synonym of that species by two eminent European Dipterologists, Zetterstedt (*Diptera Scandinaviæ*, viii, p. 3297) and Schiner (*Faun. Austr.*, i, p. 643). In the Catalogue of Diptera of Baron Osten Sacken (1878) the species appears as *Anthomyia cepurum* (Meigen, Bouché), with a reference to a note which simply mentions Schiner's reference of it to *A. antiqua*. The species seems not to be in the collections of the Cambridge Museum, for it was not among the examples of the family submitted to Mr. Meade for his examination (see page 70) and it does not appear that a critical comparison of our species with the *A. cepurum* and *A. antiqua* of Europe had ever been made. Mr. Meade, after a special study of the *Anthomyiidæ* for several years,* being at present engaged upon a Revision of the British Species† it seemed a favorable opportunity for making the desired comparison, and, accordingly, several examples of "*A. cepurum*," bred by me from onions, were recently sent to him for the purpose. The

*See a paper on the "Arrangement of the British Anthomyiidæ," in *Entomol. Month. Mag.*, xi, 1874–'75, pp. 199, 220.

†"Annotated List of British Anthomyiidæ," *Entomol. Month. Mag.*, xviii, 1881–'82, pp. 1, 27, 62, 101, 123, 172, 201, 221, 265; xix, 1882–'83, pp. 29, 145, 213.

result of the comparison is given in the following interesting communication received from him :—

"The specimens of onion-fly which you sent to me are [very nearly] identical with *Hylemyia antiqua* Mgn. The only difference between your specimens and those that I have, named by the late Professor Rondani, is that in yours, the arista is rather less pubescent. Curiously enough, I have bred several specimens myself this summer (since the part of my paper on the genus *Hylemyia* was published) from onions, some of which were sent to me by Miss Ormerod, Entomologist to the Royal Agricultural Society in England, which are all exactly like yours. They must be placed with *Hylemyia antiqua*, unless, on account of the shorter pubescence of the arista, they may be considered as a new species. They must, however, be removed from the genus *Hylemyia* (the arista not being plumose) and placed in that of *Phorbia* (part of *Chortophila* according to Rondani)."

As the result of further study, the species has been found to be distinctly separable from *H. antiqua*. Its chief points of difference are stated to be in its simply pubescent antennæ, its interrupted dorsal stripe upon the abdomen, and its clear wings, as opposed to the subplumose antennæ, a continuous abdominal stripe, and the brown wings of *antiqua*. It is represented as *par excellence* an onion-fly, as all the specimens seen, had been bred from the bulbs of that vegetable. In some instances, it had been discovered feeding upon bulbs in association with *Phorbia ciliicrura*, both species passing through their transformations at the same time.

In the *Entomologist's Monthly Magazine* for March, 1883, Mr. Meade has carefully described the species, and, in consideration of its having for some time been confounded with *H. antiqua*, has given it the name of *Phorbia cepetorum*, n. sp. Inasmuch as the *A. ceparum* of Meigen is, at the same time, given by Mr. Meade as a synonym, with doubt, of the new species,—as he also admits that it may be identical with the *A. ceparum* of Bouché and Meigen, which he has not identified,—and as there are other reasons which render it quite probable that it will prove to be the same, it seems proper that the specific name, so familiar to us from its long use, should still be employed for this species, and so continue, unless it can be clearly shown to pertain to another.

Its New Generic Position.

The genus *Phorbia*, to which the onion-fly has been referred as above, was proposed by Desvoidy, to include a portion of the old genus *Anthomyia*, which had been found to be so large as to be inconvenient and to contain greatly varying forms. The subdivisions that had been made by Desvoidy, Macquart and Rondani seem to Mr. Meade to be either too many or too artificial. In the new arrangement, which, in consideration of the critical study which has been given to it, will doubtless be generally received, he proposes to retain

the name of *Anthomyia* for a small group of the black-legged species, more highly developed than the others, having the alulets rather larger with the scales unequal in size. The remainder of the black-legged species are separated in two divisions, for the first of which *Chortophila* Macquart is adopted, to include those which have the abdomen more or less thickened and cylindrical; and to the second division, to include all those with black legs not belonging to either of the other two groups, Desvoidy's name of *Phorbia* is given. The species of this genus have the abdomen narrow and elongated, or oblong and flattened. The pale-legged species (without the limitation of Desvoidy and Macquart to those that have the body also more or less yellow) are placed in the genus *Pegomyia* Desv.

In the above genera, all the species to be noticed at the present time are arranged. The student who may desire to study this group may find them tabulated in the *Entomologists' Monthly Magazine* for July, 1882, p. 31.

Phorbia cilicrura (Rondani).

The locust-egg Anthomyian.

Ord. DIPTERA : Fam. ANTHOMYIIDÆ.

Chortophila cilicrura ROND. Att. Soc. Ital. Sci. Nat., ix, 1866, p. 165.

Anthomyia radicum var *calopteni* RILEY : Ninth Rept. Ins. Mo., 1877, pp. 92–95, f. 23 (discovery and description); Supp. Mo. Repts., 1881, p. 89 (description).

Anthomyia angustifrons MEIGEN: in First Rept. U. S. Entomolog. Commis., 1878, pp. 285–289 (from 9th Mo. Rept.); in Second Rept. U. S. Ent. Commis., 1880, p. 263 (mention).

Chortophila angustifrons Meig. OSTEN SACKEN : Cat. Dipt. N. Amer., 1878, p. 107 (citation).

Chortophila angustifrons (Meig.). MEADE : in Entomol. Month. Mag., xiv, 1878, p. 252 (in Cambr. Museum); in Canad. Entomol., 1881, p. 49 (identical with *A. rad.* var. *calopteni*).

Phorbia cilicrura (Rond.) MEADE : in Entomol. Month. Mag. xix, 1883, pp. 213, 216.

A species belonging to the same genus with the preceding, but owing its economic importance to very different habits, may next be briefly noticed.*

Discovery of its Attack upon Locust Eggs.

During the summer of 1870, when the Rocky Mountain Locust was proving so exceedingly destructive in several of our Western States, and public attention had been drawn to the study of its habits and natural history, in the hope of discovering some means of controlling its excessive ravages, the interesting discovery was made, that the eggs, which had been laid in immense numbers, had been attacked by a small "white worm or grub," which was destroying a large propor-

*Later observations have disclosed a larval food-plant in common, which intimately connects the two species. Mr. Meade has discovered *P. cilicrura* feeding on onions, and during the past summer, he has bred a number of the flies from onion-feeding larvæ.

tion of them. The following are some of the statements relating to their earliest discovery, made to Professor Riley in the summer and autumn of 1876, from correspondents in Minnesota and Kansas:

Yesterday we discovered that our locust eggs were hatching out maggots. We break open the cocoons, and the eggs on exposure to the sun for a few moments crawl away a worm. In warm places along the hedges, the earth is alive with them.— S. M. P., Hiawatha, Kansas, Oct. 30, 1876.

I find the parasites more plentiful to-day than before. The ground seems to be full of them, from five to twenty of the small white worms in a single cell. In every cell in which I have found any, the eggs were nearly or quite destroyed.— C. E. L., Rockport, Minn., Oct. 16, 1876.

A large proportion of the eggs have been destroyed by a small white larva. Many of the egg-cases, which ordinarily contain from twenty to thirty eggs, had no eggs in them, but were full of these worms or larvæ, each one of which took the place of the egg which it had destroyed.— F. H. S., Lawrence, Kansas, Nov. 1, 1876.

During the autumn of 1876, these larvæ, it was estimated, destroyed about ten per cent of the locust eggs in Missouri, Kansas, and Nebraska. They also rendered excellent service in Minnesota, Iowa, Colorado and Texas. That they had not been previously discovered may be owing to the fact that but little attention had been, before this time, given to the locust eggs.*

Description of the Insect.

The larva and the perfect insect have been popularly described by Professor Riley as follows: "This good little friend, which simultaneously prevailed over so large an extent of country, is a small white maggot, of the same general form of the common meat maggots or "gentles," but measuring, when full-grown and extended, not quite one-fourth of an inch in length. The head with some of the anterior joints of the body, tapers and is retractile, and the jaws consist of two small hooks joined to a V-shaped, black, horny piece, which, as it is

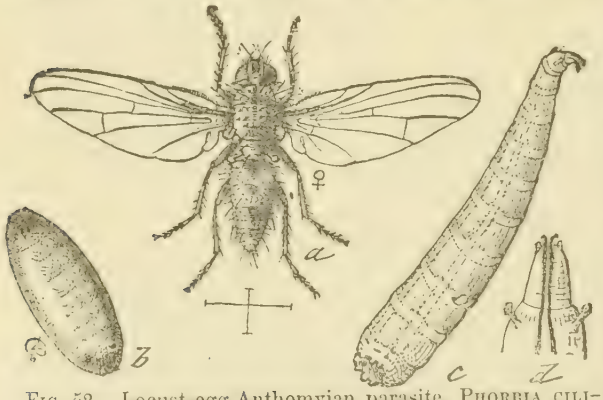

FIG. 52.—Locust-egg Anthomyian parasite, PHORBIA CILICRURA: *a*, the fly; *b*, puparium; *c*, larva; *d*, head of same —all enlarged. (Riley).

*A similar attack upon locust eggs in Asia Minor, made by a parasitic Bombyliid fly — *Callostoma fascipennis*, Macq., which had entirely destroyed the locusts throughout an area of eighty square miles, was last year brought to the notice of the Entomological Society of London. For some of the observations made upon the parasite, see the *American Naturalist* for 1882, p. 916.

retracted or extended, plays beneath the transparent skin. The hind or tail end is squarely docked off, and contains two small yellowish-brown, eye-like spots, which are the principal breathing pores.

The perfect insect issues from its puparium as a small grayish two-winged fly (Fig. 52, *a*), about one-fourth of an inch long, the wings expanding about one-half of an inch, and in general appearance resembling a diminutive house-fly, except that the body is more slender and more tapering behind, and the wings relatively more ample. More carefully examined, the body is seen to be of an ash-gray color, tinged with rust-yellow, and beset with stiff, bristle-like hairs, those on the thorax stoutest, and those on the abdomen smaller, but more uniformly distributed. The wings are faintly smoky and iridescent. There are three dusky longitudinal stripes on the thorax, most distinct anteriorly, and another along the middle of the abdomen, most distinct in the male, which also differs from the female in the larger eyes, which meet more closely on the top of the head, and in the face being whiter.

The above general description will serve for the identification of the insect when it occurs in association with locust eggs.

A detailed description of the fly, by Professor Riley, for scientific use, may be found in the 9th Missouri Report and in the *General Index and Supplement to the Missouri Reports* (*loc. cit.*); also in the *First Annual Report of the U. S. Entomological Commission*, pp. 288–89, under the name of *A. angustifrons* Meigen. We refrain from quoting it here, for while it would be of service to the entomological student to collate, as opportunity offers, the descriptions of allied species which are scattered through many volumes not conveniently accessible, and although this species is known to occur in the State of New York, yet it has not shown itself in the eastern portion of the United States, in such numbers, or with such habits, as to render it of economic importance.

The Larva feeds also upon Vegetables.

It is not at all improbable, that, in conformity with the known economy of many other insects in different localities, it may adapt its habits to the changed conditions surrounding it, and that in our State it may exist as a depredator upon the roots of some of our cruciferous plants where it may not, as yet, have been distinguished from the similar species with which it is acting in concert. As we have recently found no less than three species, differing but slightly in specific characters, infesting the leaves of beets, in company (and two other species are known in Europe), it is probable that several of the Anthomyians may be jointly operating upon the roots of the cabbage and the radish. Indeed, Professor Riley states (9th Missouri Report, p. 95), that speci-

mens in his cabinet, bred from cabbage and radish roots, *do not differ specifically* from those *reared from the locust-egg feeding larvæ.*

Synonymy of the Species.

From its general resemblance to the *Anthomyia radicum* of Europe, it was at first regarded by Professor Riley as simply a variety of that form, and it was accordingly characterized by him as *A. radicum* var. *calopteni*. Examples having been submitted to Mr. Meade, they were by him referred to *Anthomyia angustifrons* of Meigen, which had been placed by Rondani in the genus *Chortophila*. Recently Mr. Meade informed me that *C. angustifrons* Meig. has been found by Rondani to embrace three or four distinct species, differing in slight points of structure, and that our locust-egg feeding species seems to correspond to the one named by Rondani, as *Chortophila cilicrura*.* In the recent re-arrangement of the *Anthomyiidæ*, it falls into the genus *Phorbia*. *Aricia fusciceps* Zetterstedt, is believed to be a synonym of this species.

Anthomyia brassicæ Bouché.

The Cabbage-Fly.

Ord. DIPTERA: Fam. ANTHOMYIIDÆ.

BOUCHÉ: Naturgeschichte der Insecten, 1834, p. 74, pl. 5, f. 34.

KIRBY-SP.: Introduc. Entomol., 1846, p. 140 (infesting cauliflowers).

CURTIS: Farm Insects, 1860, p. 141, figs. 1, 2 and 3 of no. 26, p. 143.

FITCH: Eleventh Rept. Ins. N. Y., in Trans. N. Y. State Agricul. Soc. for 1866, xxvi, 1867, pp. 496–499.

RILEY: First Ann. Rept. Ins. Mo., 1869, p. 156 (mention); Fourth Rept. do., p. 22 (parasite); Ninth Rept. do., p. 95 (mention).

SPRAGUE: in Amer. Entomol., ii, 1870, pp. 302, 370 (Aleochara parasite).

GLOVER: MS. Notes Journ.—Entomolog. Index, 1877, p. 5 (references).

OSTEN SACKEN: Cat. Dipt. N. Amer., 1878, pp. 167, 258.

BARNARD: in Amer. Entomol., iii, 1880, p. 199 (abundance of parasites).

COOK: in Amer. Entomol., iii, 1880, p. 264; in Canad. Entomol., xiii, 1881, p. 190 (remedy).

GARFIELD: in 16th Rept. Mich. St. Board Agricul., 1878, p. 61 (experiments with remedies).

ORMEROD: Manual Inj. Ins., [1881], p. 31, figs. 1, 2, 3 (habits, transformation and remedies).

Its Operations Upon Cabbages.

This is probably the most injurious species of the *Anthomyiidæ*, as its distribution is very extensive both in Europe and America, and it has shown at times such capacity for multiplication as to cause entire

*This species should not be confounded with the *Homalomyia ciliicrura* of Rondani (which is a synonym of *H. floricola* Meig.), for, according to Mr. Meade, Rondani very strangely gave the same specific name to two quite distinct Anthomyians.

destruction of cabbage crops. It commences its attack upon the young plants while yet in the seed-bed, and continues to infest them, in several successive broods, until they are taken up in the autumn. The larvæ operate by consuming the rootlets of young plants, and by excoriating the surface and eating into the rind of older ones, or even penetrating into the interior of the root. When they abound to the extent of seriously burrowing the stalk, the decay of the root frequently follows, in wet seasons, and entire fields are thus destroyed. They are usually to be found in the swellings upon the roots, and the species is one of those which Curtis notices as infesting "anbury."

Its Injuries not Confined to Cabbages.

It also attacks the turnip, mining into its interior in an irregular burrow, or occupying eroded spots upon its outer surface. "Sometimes a small roughened spot is seen, appearing like a crack in the skin of the turnip, with its edges rough and ragged and turned outward, and on paring off the roughened spot a plump white maggot is come upon, lying in a cavity it has there made for itself. At other times a larger eroded spot occurs, which is filled with wet and slimy dirt. On removing this dirt, the surface is found to be rough and warty, with little grooves here and there, in each of which is a maggot." (Fitch).

Kirby and Spence (*Introduc. Entomol.*, 1846, p. 140) evidently refer to this species, when they mention that "one of the most delicate and admired of all table vegetables, concerning which gardeners are most apt to pride themselves, and bestow much pains to produce to perfection — the cauliflower — is often attacked by a fly, which, ovipositing in that part of the stalk covered by the earth, the maggots, when hatched, occasion the plants to wither and die, or to produce a worthless head."

When and Where First Described.

A. brassicæ was described by Bouché, in 1834, as above cited. It is thought by Schiner,* that it may have been previously described by Meigen, in 1826, as *A. ruficeps*. If the two are hereafter shown to be identical, then the northern range of the cabbage-fly will be extended into Greenland, whence examples of *A. ruficeps* have been received. There is an older *A. brassicæ*, viz. that of Weidemann (*Zoolog. Mag.*, i, p. 87), which is a different species, and has recently been referred by Mr. Meade to *A. radicum* Linn.†

* Schiner, *Fauna Austriaca, Dipt.*, i, p. 644.

†With *A. ruficeps* Meigen, Mr. Meade is not acquainted.

Its Resemblance to A. radicum.

Dr. Fitch (*loc. cit.* p. 497) declares his inability to separate *A. brassicæ* from *A. radicum*, the root-eating species, either by a comparison of the larvæ occurring in the roots of the cabbage, turnip and radish, or by descriptions given by authors of the two species. The difference in the color of the larvæ indicated by Curtis — that of the former being yellowish-white and of the latter yellowish-olive — he regards as unreliable, as he has found them pure white when first taken from their burrows in the roots, and from exposure to the light they acquired a yellow tinge, which became deeper as they were longer exposed.

Description of the Larva, Puparium and the Fly.

The best description of the insect given is that of Dr. Fitch, from which we quote: "The larvæ occur of different sizes at the same date, the largest measuring 0.30 in length. They are footless and white, composed of ten or eleven visible segments. On the throat or underside of the pointed end the jaws appear as a bifid black internal streak. The hind end is bluntly cut off and flattened, with two elevated tawny yellowish dots or spiracles on the disk, and around the margin is a row of twelve conical fleshy points, the lower two larger and forked at their tips, the next one on each side equally long but narrower and acute pointed, and forward of these last is another transverse row of similar points. [Kollar states that the truncated anal joint is surrounded by *ten* fleshy points, of which the four lower are in pairs. According to Curtis, it has two brown tubercles in the center, and several short teeth on the lower margin.]

The puparium is described in such general features as not to be serviceable for separating it from the allied species. The pupation continues for about a fortnight when the perfect insect is given out, "which is a two-winged fly, resembling the common house-fly, but, somewhat smaller in size, measuring 0.20 in length to the end of its body, and 0.26 to the tip of the closed wings. It is of an ash-gray color, and with three black stripes on the thorax or fore body, and on the hind body a black stripe along the middle of the back, and a black band upon each of the sutures. In the male the head is silvery-white, the eyes coppery-red in the living specimen, and very large, nearly in contact above — having between them a black stripe, which is much broader at its commencement at the base of the antennæ. The antennæ, feelers and legs are black. On the crown of the head, the legs, and the hind body are black bristles, and on the fore body are coarser ones, arranged in rows. The hind body is of a cylindric-conic form, its under side with a black stripe in the middle and black bands on the sutures, similar to the upper side. The wings are hyaline, ciliated

with fine bristles along the outer or costal edge, nearly to the tip. At the apex of the first vein is a slight notch, where is a coarser bristle.

"The female differs in having the eyes smaller and farther apart, and the black stripe between them is much broader, and is tinged with tawny-red in its middle, and forked at its upper end, with a small black spot between the forks. The black stripes on the fore body are obsolete, as are also the black bands on the sutures of the hind body."

Natural Enemies.

According to Curtis, the cabbage-fly is not known to have any parasite destroying it in Europe. A small four-winged Ichneumon, belonging to the Hymenoptera, known as *Alysia manducator*, lives in the pupæ of several flies allied to *Anthomyiidæ*. It undergoes its transformation in a thin, yellow case, within the pupæ, and emerges in the spring and summer, when it may frequently be seen about decaying turnip and other roots. It may, therefore, be inferred that it is a general parasite of these flies, and that the cabbage and turnip larvæ do not escape its vigilance.

In our own country, a parasite upon *A. brassicæ* has been discovered, from which much service is expected in checking the depredations of this injurious species. It is a small beetle, belonging to the family of *Staphylinidæ*, which are sometimes known as rove-beetles.

The Staphylinidæ.—These beetles are characterized by their narrow, elongated and somewhat flattened bodies, which vary in size from about an inch in length to a microscopic form. Their wing-covers are very short, often extending only over a small portion of the abdomen, leaving the greater part uncovered and left free to be raised upward in running, or employed for folding and packing up the true wings under their abbreviated covers after flight. The end of the body often bears two bristly processes. The jaws (mandibles) are long and curved, and are used in a menacing and formidable manner when the insect is taken in the hand; when at rest, or in cabinet specimens, they are usually crossed at the tips. The antennæ are short, composed of short rounded or lenticular joints, which frequently increase in size toward the tips. Their food consists largely of decaying animal and vegetable matter, rendering them very useful as scavengers. Some of the species attack and destroy other living insects, and are so cannibalistic as to prey upon their own species. Others are true parasites, and find their food in the larvæ of ants' nests, in the nests of wasps, in beetles, and doubtless, from recent observations, and an increased knowledge of their habits, in many more insects than are now suspected. The family is a very large one, more than five hundred North American species having been described. *Leistotrophus cingulatus*

(Grav.), and *Staphylinus cinnamopterus* Grav., are among the species frequently met with in the State of New York.

ALEOCHARA ANTHOMYIÆ *Sprague.* — The particular species which is parasitic on the larvæ of the cabbage-fly was discovered a few years since, in a garden near Boston. According to the account given (*loc. cit.*) by their discoverer, Mr. P. S. Sprague, some cabbage-plants which had just been set out gave indication, by their wilting and discoloration, of insect attack. On taking them up, from ten to thirty of the cabbage-fly larvæ were found upon each plant. They had destroyed all of the tender rootlets, and were following the center of the main stock to the surface of the ground. Subsequently (June 20th), twenty-six puparia were collected from the soil of the hills and put in boxes of earth, one moist and the other dry. From these, there were obtained, about the middle of July, seven examples of the parasitic beetle, which had eaten their way through rough holes in the sides of the puparia. No wound or marks could be found upon their exterior, to indicate that the attack had been made while in that stage, and the inference therefore was drawn, that the larvæ had been parasitized, either by the eggs of the beetle having been fastened to their bodies, or by the direct entrance of the young parasitic larvæ An examination of the beetle showed it to be an unknown species, and it was accordingly described by Mr. Sprague as *Aleochara anthomyiæ*. Fig. 53 represents the insect — the hair-line beside it indicating its natural size.

FIG. 53.— ALEOCHARA ANTHOMYIÆ,— parasitic upon the cabbage-fly.

The only knowledge that we have of the habits of this insect is given us by Professor W. S. Barnard, as follows: "It is now very abundant at Ithaca. * * * * * * The beetles are often seen running from one young cabbage to another, or entering holes, but more commonly close about the stalk. Half of our young cabbages here, last year and this, have been killed by the maggots, and now, on pulling up an infested stalk, these beetles often come out, sometimes several from about one plant. To test their habits, I put a maggot in a bottle with them. When hungry, a single one alone will attack a full-sized maggot, tearing open its sides and feasting upon it. I have seen five of them like a pack of wolves cling to, and tear, a writhing maggot, killing it quickly. They are wonderfully active, and promise to be the best enemy against the fly which has ruined so many crops here." (*Amer. Entomol.*, iii, 1880, p. 199.)

Of the other species of *Aleochara* which occur with us, doubtless some will hereafter be shown to be of similar service. Nine species are recognized in this country, of which two are identical with European forms, viz., *A. brachypterus* (Fourc.), and *A. nitida* Grav.

Parasitism of the Staphylinidæ.—The above parasitic attack is of much interest in connection with our efforts to check the ravages of these root-eating larvæ. It would not be confined to the cabbage-fly larva, but would doubtless embrace all the allied species existing under similar conditions. The *Staphylinidæ* or rove-beetles have long been known to abound in the diseased and distorted roots of the cabbage and turnip. Curtis states (*op. cit.*, p. 138) that different species of *Aleochara* and *Oxytelus** are frequently found in England, in decayed turnips, and that in one instance, forty or fifty of the larvæ of a *Staphylinus* had been taken from below the leaves of a single bulb. Some specimens of the same genera were discovered gnawing the roots in July, and "two of the beetles lived three months upon maggots occurring in some turnips."

As it is highly probable from the above statements of Curtis and from other knowledge that we have of the habits of the *Staphylinidæ*, that a large proportion of their food consists of living larvæ — the injury that they may at times inflict by gnawing the roots of vegetables is many times compensated by their predilection for living animal food, and particularly for tender larvæ.† It is, therefore, very desirable, that these serviceable predatory and scavenger beetles should not be harmed when discovered in their favorite retreats, in association with injuries which would naturally, in the absence of a knowledge of their habits, subject them to unjust suspicion and seem to authorize their destruction.

Possible Introduction of Parasites from Europe.

In the large importation of cabbages from Europe, following the widespread destruction of our crop of the past year (1881),‡ among the new species of insects that will in all probability be brought over, it is to be hoped that some useful parasites upon the cabbage-fly may at the same time have been introduced, toward compensation for the losses sustained in the sending hither, about twenty-five years ago, the destructive cabbage-butterfly, *Pieris rapæ*, and at another time, *Plusia brassicæ*, if its recently asserted identity with *Plusia ni* Hübn.

*On page 139 (*l. c.*), *Oxytelus sculpturatus* and *O. rugosus*, which infest turnips and the clubbed roots of broccoli in England, are figured.

†See statement in the *8th Annual Report on the Insects of Missouri*, of these beetles pursuing and devouring the "snake-worm" — a name given to an assemblage of the larvæ of *Sciara* (a genus of small gnats), which have the strange habit of traveling in large companies, in which all the individuals are attached to one another, heads to tails, and the entire body moving together as if guided by a common impulse.

‡The high price of cabbages — from $15 to $30 per hundred, wholesale — has led to large importations from Germany. They are brought in crates, and some sour-krout is imported ready pickled in tierces. Turnips, celery and carrots are also to be seen among the freight of all incoming vessels.— *New York Post*, December, 1881.

shall be established. To the increasing ravages of these two species this novel importation is mainly attributable.

Preventives and Remedies.

Various means have been suggested for controlling the depredations of the cabbage-fly. Bouché, the original describer of it, tells us that the plants may be preserved by dipping the roots when they are transplanted from the seed-beds, into oil or lye of ashes.

Powdered tobacco, or the fine dust from tobacco factories, scattered over the plants, is said to preserve them from attack.

The use of superphosphate of lime has been advised, as a preventive against the deposit of the eggs.

If cabbages are not grown upon the same ground for successive years, and the ground meantime thoroughly cultivated with some other crop, the insect will be materially reduced in numbers.

In the experiments at the Michigan State Agricultural College, referred to on p. 193, a strong decoction of tobacco was freely applied to the plants, but without appreciable benefit.

When the attack of larvæ has reached that stage of progress that the plants unmistakably show it by wilting and the leaves turning to a faint lead-color, all such should be promptly taken up, and the hole left should be filled with strong brine or lye to destroy any of the larvæ which might remain in the soil. This last precaution would be unnecessary if the plants were removed by the method recommended for onions (p. 178), but in that case, the accompanying ground should be thrown with the plants in a deep hole made for the purpose, and covered with solidly packed earth, through which the flies, if any of the buried larvæ should attain this stage, could not penetrate to the surface.

Watering the plants with lime water has been found to be of service in killing the larvæ.

Professor A. J. Cook has recently recommended the following method for the destruction of the larvæ. Bisulphide of carbon is used. "To apply it, a small hole is made in the earth near the main root of the plant, by use of a walking-stick or other rod, and about one-half a teaspoonful of the liquid poured in, when the hole is quickly filled with earth, which is pressed down by the foot. In every case the insects were killed, without injury to the plants." *Amer. Entomol.*, iii, 1880, p. 264.

While Professor Cook, as the result of the experiments of the present year, believes carbolic acid to be preferable to bisulphide of carbon for the protection of radishes (see p. 194), he is still of opinion that the latter material is the most reliable in contending with the cabbage-fly,

and that its use, as above recommended, promises to be the cheapest and most desirable means that can be made practicable on all occasions. (*Canad. Entomol.*, xiii, 1881, p. 190.)

Anthomyia radicum Linn.

The Root-fly.

Ord. DIPTERA: Fam. ANTHOMYIIDÆ.

LINNÆUS : "Faun. Suec., Ed. ii, 1761, p. 75, no. 1840. Syst. Nat., xii ed., ii, 1767, p. 992, no. 79."

WEIDEMANN : in Zoölogical Magazine, i, p. 87 (*A. brassicæ*, but according to Meade is *A. radicum*).

CURTIS : Farm Insects, 1860, p. 143, f. 26, nos. 4, 5 (brief description).

FITCH : Eleventh Rept. Ins. N. Y., in Trans. N. Y. St. Agricul. Soc. for 1866, xxvi, 1867, p. 497 (compared with *A. brassicæ*).

GLOVER : in Ann. Rept. Commis. Agricul. for 1872, (1874), p. 134 (food-plants); MS. Notes Journ.—Dipt., 1874, p. 3, pl. 10, f. 9 (references, etc.).

PACKARD : in Hayden's Ninth Rept. G. G. Surv. Terr., 1877, pl. 63, f. 2 (imago only).

RILEY : in First Ann. Rept. U. S. Ent. Commis. for 1877, (1878), p. 288, f. 22 (imago only).

HAGEN : in Canad. Entomol., xiii, 1881, p. 48 (identified by Meade).

ORMEROD : Manual Inj. Ins. [1881], p. 33, fig. 4 on p. 31 (brief notice).

MEADE : in Entomol. Month. Mag., xix, 1882, p. 32 (general features).

As this European species has been referred to in the notice of the preceding species, as a closely allied and possibly an identical form, a brief notice of it will be proper here, particularly as it is known to occur in the United States,* although no injuries have as yet been traceable to it.

Described and Noticed in Europe.

The species was originally described by Linnæus in the year 1761, in his *Fauna Suecica*, ed. ii, p. 75, no. 1840, as *Musca radicum*, — nearly all of the flies known to this distinguished Naturalist, having been arranged by him in the four genera of *Tipula*, *Musca*, *Tabanus* and *Culex*.

It does not appear to have been numbered among the more destructive species of Europe. Mr. Kollar, in his well-known volume, prepared under the authorization of the Emperor Francis I. of Austria, and command for its speedy execution, in the examination of, and report upon, "the most important enemies of the agriculturist," does not include this insect while noticing the onion-fly, the cabbage-fly and the lettuce-fly (*Anthomyia lactucarum* Bouché).

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*Meade: *Ent. Month. Mag.*, xiv, 1878, p. 252.

Curtis, in his *Farm Insects*, gives but a brief account of it. It is placed under the "Insects affecting the turnip crops," and more particularly under those infesting "anbury." Anbury is defined as a malformation or large excrescence produced below the bulb of certain vegetables, which, when they arrive at maturity, exhibit a putrid fermentation and emit a most offensive smell. When the anburies are divided they are hard; but with the assistance of a lens, veins or string-like vessels may be seen dispersed through the tumor. It is believed by Curtis that they are not occasioned by insects, but are subsequently entered and occupied by multitudes of maggots, which feed upon the putrid substance and contribute in no small degree to the more speedy dissolution of the bulbs. The cause of the disease is probably to be found in certain conditions of the soil, induced, perhaps, by the long-continued repetition of certain crops.

The eggs of the root-fly are deposited in the crown of the turnip or close to the young bulb. Hatching, the larvæ proceed downward to the bulb, into which they enter and where they are to be found, and not in the surrounding soil, as frequently in the onion-fly. They are described by Curtis, from examples taken from turnips on July 21st, as follows: "Similar in form to those of *A. brassicæ*, but of a yellowish-ochre color. The head was armed with two black hooks, and at the extremity was a green stripe from the intestines, showing through; the rump was truncated, and furnished with two brown projecting spiracles, and the margin surrounded with small teeth, largest below. I put them, with a turnip root, into a flower pot, and the following April I found four of them in the pupa state, and buried deep in the earth; these pupæ were also like those of *A. brassicæ*, but of a paler color, being lurid ochreous. On the 26th of April I bred a male fly, and soon after two females.

"The fly is similar in size and form to *A. brassicæ*, but the *male* (Fig. 54) has an ochreous face, reflecting satiny-white; the stripe on the forehead is rusty; the thorax is black, with three darker stripes; the sides are gray; scutel blackish; abdomen slender, linear shining gray, with a broad black dorsal stripe; the incisures are black also; wings, balancers and legs as in *A. brassicæ*. *Female* still more like that species; but there are three fuscous stripes on the thorax, and in certain lights a slender dark line down the back of the abdomen; length, 2 1-2 lines."

FIG. 54.—The root-fly, ANTHOMYIA RADICUM Linn. The fly only, not the figures. (After Curtis.)

Miss Ormerod, writing the present year of this insect, says: "These

flies are not noted as causing any serious damage in this country, but may be mentioned from their great resemblance to the common cabbage-fly." From the similarity in appearance and habits of the two species, it would not be strange if the injuries of *A. radicum* were much more common than is generally supposed, and that much of the damage ascribed to *A. brassicæ* in reality pertains to the former species.

Mr. Meade (*loc. cit.*) remarks of this species as follows: "This excessively common little fly, which, as its name imports, feeds in the larva state upon the roots of plants, especially those of the cabbage tribe, is often confounded with other species. It may be recognized by its projecting epistome [the lower face]; by the unequal sized scales; by the thorax being black and marked in the male by two short, gray, narrow stripes (rather than by three wide black ones, as is usually stated); by the rather short, wide, somewhat pointed abdomen, with a longitudinal dorsal black mark, crossed by three transverse straight black lines, extending of an even width to the margin; and by the third and fourth longitudinal veins [see figure of venation, *ante*, for position of these veins] being slightly convergent at their extremities."

Briefly Noticed in this Country.

The above meager account of this insect, which, from its specific name, together with its habits, so far as known, should be of considerable economic importance, is all that can be compiled from the sources at my command. While quite unsatisfactory, it may at least serve to show our ignorance of the species, and incite to efforts for the attainment of a fuller knowledge of it.

Dr. Packard's notice of "*A. radicum*," contained in his Report on the Rocky Mountain Locust (*9th Ann. Rept. of the U. S. Geolog. and Geograph. Survey of the Territories*, for 1875), is that of the radish-fly, *A. raphani*, in acceptation of Dr. Fitch's belief in their being the same. Of the figures given in illustration, on plate lxiii, fig. 3, the same as Fig. 54 above, the fly alone represents *A. radicum*, while *a*, *b* and *c*, showing larva in double size, and pupa-case in natural size and enlarged, are from Curtis' figures of *A. brassicæ* (*b*, to show the natural size of the puparium, is very badly copied). The same figures are introduced in the *First Annual Report of the U. S. Entomological Commission* (p. 288, fig. 22, *a*, *b*, *c*) to illustrate *A. radicum*.

Mr. Glover (*loc. cit.*) refers to *A. radicum* as injuring radishes in Europe. Dr. Fitch's notice of the species is limited to a comparison of it with *A. brassicæ*, which has been quoted on a preceding page (p. 186).

Remedies and Preventives.

Salt and lime combined, and mixed with the soil previously to sowing the seed, or applying it to the surface after sowing, was attended with excellent results. A correspondent of the *Gardener's Magazine*, recommends "for the protection of turnips against the attacks of the fly and other insects, that the plants be made offensive to the parent fly, which may be done by incorporating with the soil soap-boilers' waste, or any other substance of similar alkaline quality." It is recommended that the plants be watered with "a mixture of one gallon of soap-suds to one gallon of gas-water, or, in lieu of the latter, two quarts of gas-tar; either will do, as the only use of the mixture is to create an offensive smell."

It will be seen that the above recommendations are similar to the means adopted by Professor Cook for averting the attack of the radish-fly by the odor of carbolic acid.

In experiments made by the Zoölog.-Botan. Society of Vienna, plants were preserved from attack by manuring the ground with superphosphate.

Anthomyia raphani Harris.

The Radish-fly.

Ord. DIPTERA: Fam. ANTHOMYIIDÆ.

HARRIS: Rept, Ins. Mass., 1841, p. 415; Treat. Ins. New. Eng., 1852, p. 494; Ins. Inj. Veg., 1862, p. 617 (brief description of the fly).

FITCH: Eleventh Rept. Ins. N. Y., in Trans. N. Y. St. Agricul. Soc. for 1866, xxvi, 1867, pp. 515–517.

PACKARD: Guide Study Ins., 1869, p. 411 (mention).

TRIMBLE: in Amer. Entomol., ii, 1870, p. 273 (habits in N. J.).

GLOVER: MS. Notes Journ.—Dipt. 1874. p. 3 (reference and habits).

COOK: in Thirteenth Ann. Rept. Mich. St. Board Agricul. for 1874, (1875), p. 121 (natural history and remedies); in Canad. Ent., xiii, 1881, p. 190 (carbolic acid remedy).

PACKARD: in Hayden's Ninth Rept. G.–G. Surv. Terr., 1877, p. 762, pl. 63, f. 2 of *radicum* from Curtis (description from Fitch).

GARFIELD: in Sixteenth Ann. Rept. Mich. St. Board Agricul. for 1877, (1878), p. 61 (experiments with remedies).

OST. SACK.: Cat. Dipt. N. Amer., 1878, p. 168 (references and localities).

The most Injurious of Radish Insects.

For some reasons not evident to us, the radish is not subject to the attack of as many species of insects, as are most of our vegetables and garden plants. We can recall at the present comparatively few which prey upon it. The caterpillar of the white cabbage-butterfly *Pieris rapæ*, is sometimes found feeding upon its leaves. Two of the flea-

beetles, *Epitrix cucumeris* (Harris), and *Orchestris vittata* (Fabr.), are serious depredators upon the foliage, which they eat so full of small holes as materially to interfere with the vigor of the plant. A small weevil has been observed by Dr. Packard, in Maine, eating holes through the sides of the seed-pods and devouring the seeds,* which he believes to be identical with the radish-seed weevil, *Ceutorhynchus assimilis* Payk., of Europe. The Harlequin cabbage-bug, *Murgantia histrionica* Hahn., injures it severely in the Southern States; while in the western portion of the United States, another member of the order of bugs, *Nysius destructor* Riley, which resembles the chinch-bug so closely in appearance that it has been taken for it, and has received the popular name of the false chinch-bug, — sucks the juices from the leaves and causes them to wilt,† while the Rocky Mountain locust, *Caloptenus spretus*, eats its leaves with great avidity.‡

Of greater magnitude than all the above combined, are the injuries inflicted upon radishes by the larvæ of the radish-fly. Throughout at least the northern part of the United States, wherever they are cultivated, these larvæ may be found burrowing into the roots, and rendering them unsightly, hard, gnarly, stringy, and unfit for the table. They traverse the root in all directions, extending often an inch or two in its interior. In many localities they abound to such an extent that no radishes can be grown without great injury from them, and often they compel the entire abandonment of its cultivation.

Description of the Insect.

This species was first described by Dr. Harris in his Second Report to the Legislature, on the *Insects of Massachusetts*, published in the year 1841. It had been named by him in his List of Insects, contained in the *Catalogue of Animals and Plants of Massachusetts* (page 80), published in 1835, together with several other species of *Anthomyia*,§ of which this only seems to have been subsequently described. The description is as follows: —

"Radishes, while growing, are very apt to be attacked by maggots, and rendered unfit to be eaten. These maggots are finally transformed to small, ash-colored flies, with a silvery-gray face, copper-colored eyes, and a brown spot on the forehead of the females: they have some faint brownish lines on the thorax, and a longitudinal black line on the hind-body, crossed by narrower black lines on the edges of the rings. They vary in size, but usually measure rather more than one-fifth of

*Ninth Ann. Rept. Geolog.-Geograph. Surv. Terr., 1877, p. 763.

†Fifth Ann. Rept. Ins. Mo., 1873, p. 111.

‡Seventh Ann. Rept. Ins. Mo., 1875, p. 159.

§The other MS. names are the following: *lunatifrons, timida, notatifrons, calcola, ischiaca, goniphora,* and *lenis.*

an inch in length. They finish their transformations, and appear above the ground, toward the end of June. * * * * It closely resembles the root-fly (*Anthomyia radicum*), of Europe."

Dr. Fitch has given a more detailed description of, presumably, the same insect: "The larva is 0.20 long, elongating itself to 0.25 when crawling. It is about three times as long as thick, appearing to be more short and broad than the larva of the onion-fly. It is white, shining, cylindrical and tapering to a point anteriorly, where the jaws appear under the skin as a short, black, movable line, its anterior end when protruded forward becoming split, and then seen to be two sharp hooks, which are curved downward, and when the animal is crawling these hooks are pressed downward against the surface to aid locomotion. The body is divided by transverse lines into eleven or twelve segments, and when the head is exserted, thirteen segments can be counted. At the hind end of the back a pale, tawny, yellowish dorsal stripe is faintly visible. The hind end is abruptly cut off, obliquely downward and slightly backward, forming a flat surface, having above its center two conspicuous spiracles or elevated dots, their surface opake and rugose, and their color sometimes tawny-yellow, sometimes black. The flattened hind end has a number of small acute teeth around its outer margin, of which the two lower ones are thicker, of a brownish color, and slightly notched or two-toothed at their tip in the large but not in the smaller young larvæ. Above these on each side are three teeth, distant from each other, the middle one nearer to the upper than to the lower one."

Although Dr. Fitch adopted the specific name given by Dr. Harris, yet he states that "it appears to be identical in every particular with the European *A. radicum*." Farther on, he indicates these differences: "The worm and also the pupa differs in no respect from those of the Onion-fly, that I perceive, except that at the hind end the two larger teeth on the middle of the under side are slightly notched or two-toothed at their tips, instead of being tapered to a single point. The flies, too, are very similar, but here three faint brownish stripes are perceptible on the thorax or fore-body, and upon the hind-body in the male is a black stripe along the middle of the back, which is crossed by narrower black lines on each of the sutures."

The following is a detailed description of the flies:—

"The *male* is ash-gray and very bristly; the large compound eyes occupy most of the surface of the head and are almost in contact upon the crown. There are also three minute eyes at the base of the crown. The face is silvery-gray, almost white in some reflections of the light, with a long black streak on the forehead, which is pointed at its hind end. Below this streak are the black three-jointed antennæ, the basal

joint being small, the second large, the third largest and oval, with a two-jointed pubescent bristle on the back, the first of the joints being very minute. The fore-body is oblong, whitish on the sides, with three faint interrupted dusky stripes upon the back. The hind-body is shining gray, rather small and elliptical, tapering to the apex, with a black stripe down the back, the edges of the segments and the region of the scutel being also black. The two wings are large, transparent, iridescent, laid the one upon the other in repose, the longitudinal veins extending to the margin, with two transverse veinlets in the disk. The poisers are pale yellowish. The six legs are black and bristly, the feet five-jointed, ending in two little claws, and two large pale leathery lobes.

"The *female* is of a uniform ash-gray color, excepting the silvery-white face and pale sides of the fore-body. The eyes are widely apart, with a broad black stripe between them, which is shaded into chestnut color in front. The hind-body is larger than in the male and conical toward its apex. The wings have a tinge of yellowish at their bases. The species measures 0.22 in length, and 0.45 in width across the extended wings."

Natural History.

The history of this insect does not appear to have been carefully observed. Dr. Harris' only statement is that the fly emerges from the ground toward the end of June. Dr. Fitch states that the pupa state lasts for two or three weeks. Professor Cook, of Lansing, Michigan, writes: "The flies are around early in the spring, for our earliest radishes are the ones most liable to suffer from attacks. The eggs are laid on the stem close to the ground. These soon hatch. * * * In June they transform to pupæ and to imagos, and are ready to make a new deposit of eggs. Whether there are more than two broods a year, and whether they attack other plants than radishes, are, so far as I know, still open questions." The observations of Dr. Fitch, in relation to the early appearance of the fly, are somewhat at variance with the above. It was only from his earliest-sown radishes that he obtained any that were fit for use, but he adds, "for several years past, the first sowing has also been a total failure." It is not improbable that with a more thorough establishment of the fly among us, its first appearance in the spring may be earlier than it was wont to be.

Its Literature.

Very little, beyond that above referred to and quoted, has been written of this species. We find nothing in the Reports of Mr. Glover, during his long connection with the United States Agricultural Department,

ment, either of its occurrence, distribution, or habits, beyond a simple mention of it as injurious to radishes (Report for 1872, p. 134). In his "MS. Notes from my Journal," a few copies of which were lithographed for private distribution, some references to writers are given (p. 3). Professor Riley's Reports contain no notice of it. Dr. Packard refers the species to *Anthomyia radicum*, of Europe, and records its frequent occurrence in early-sown radishes in Maine, where the plants were sometimes killed by it.

A Doubtful Species.

While we still retain *A. raphani* among our list of depredators on the radish, it is uncertain whether it is distinct from the European species described by Linnæus, in 1761, as *Musca radicum*. The type is probably not in existence, as it is not contained in the Harris collection in the Museum of the Boston Society of Natural History. There are no specimens of it among the *Anthomyiidæ* of the Museum of Comparative Zoölogy at Cambridge. Mr. Meade, of England, in reply to inquiries made of him, informs me that he has not seen and does not know the species. A single specimen of it, labeled by Dr. Fitch, is in the collection of the N. Y. State Agricultural Society, but in too poor condition for satisfactory comparison.*

There is, in favor of the identity of the two species, in addition to their qualified identity stated by Dr. Fitch, the fact that an example of *A. radicum* Linn., was found by Mr. Meade in the collections of North American *Anthomyiidæ* sent to him for examination from the Cambridge Museum: the particular locality is not indicated (*Canad. Entomol.*, xiii, p. 48, no. 52).

Remedies and Preventives.

At the State Agricultural College of Michigan, experiments were made with tobacco-water, superphosphate, and gas-lime, upon alternate rows of radishes, hoping that the effect might be, by means of a vile odor, to prevent the flies from laying their eggs. These applications were all failures.† The earth was partially removed from the roots and salt thrown in and covered up, but to no purpose. Boiling water was poured upon the roots, and when the larvæ were not too deep in the ground, this was effectual, but was not accounted a successful

*A difference is shown in the neuration, which, could it be sustained by other examples, would be of no little importance in the separation of these closely allied forms. The two longitudinal veins 3 and 4 do not converge at the margin, as in most of the allied species, and the hinder transverse vein (9) is more conspicuously angulated at the middle than in any other of the Anthomiæ before me (resembling in these features *Pegomyia vicina*, hereinafter described).

†It does not appear from the statement, that the applications were made before the first flies had come abroad for the deposit of their eggs.

remedy. Not one-tenth of the radishes were saved (*Rept. St. Board Agricul.* for 1877, p. 61).

It is thought that benefit has been derived from late sowing in clayey soil, as the insect has been observed to be very injurious to earlier crops and upon sandy soil.

Professor Cook last year recommended the use of bisulphide of carbon for the destruction of the larvæ, but he has subsequently concluded, in consideration of the amount of the liquid necessary for thorough execution, that the expense would be too great to warrant its use. The trial was made to lessen the expense by applying the liquid in fewer places in the beds, at some distance apart, but it did not give as good results as when similarly used for the destruction of the cabbage Anthomyia. During the present year, he has experimented with carbolic acid, as a cheaper agent, known to be very repellant to insects, and remarkable for retaining its disagreeable odor for a long time. It was prepared by adding two quarts of soft soap to two gallons of water, to which, when heated to the boiling point, a pint of crude carbolic acid was turned in. For use, one part of this mixture was taken with fifty parts of water, and applied by sprinkling directly upon the plants. It was used in three localities in the college grounds, and it was found that a single application kept the insects at bay for about two weeks. When applied weekly, the radishes were almost entirely free from attack, although the flies were observed and captured in the vicinity, and some beds near by, but not protected by the carbolic liquid, were badly injured. It is recommended to sprinkle the plants as soon as they are up, and to repeat the operation every week or ten days thereafter; and the caution is appended, "if sprinkled directly upon the plants, the mixture must not be so concentrated as to injure them."

The above method gives promise of enabling us to prevent the ravages of the radish-fly (and of many other insects), by simple but effectual means. It will be very encouraging if subsequent experiments with the carbolic acid liquid in other localities and under different conditions of soil are attended with results quite as satisfactory as those above recorded.

Anthomyia zeæ Riley.

The Seed-corn Fly.

(Ord. DIPTERA: Fam. ANTHOMYIDÆ.)

Anthomyia zeæ Riley: 1st Rept. Ins. Mo., 1869, pp. 154–156, figs. 86, 87, pl. 2, f. 24.
A. zeæ Walsh: in Amer. Entomol., i, 1869, p. 224, figs. 158, 159.
A. zeæ Packard: Guide Study Ins., 1869, p. 411, f. 344 (mention).
A. zeæ Glover: MS. Notes Jour.–Dipt., 1874, p. 3, pl. 8, f. 26; pl. 9, f. 33.
A. zeæ Riley: Gen. Ind. and Supp. Repts. Ins. Mo., 1881, p. 89.
A. zeæ Ost. Sacken: Cat. Dipt. N. Amer., 1878, p. 168.

The operations of this insect were first detected in New Jersey, in

the year 1868, in the month of June, by Mr. A. S. Fuller, where it was found as a small white worm eating into and excoriating the surface of seed-corn after its sprouting. In several localities in New Jersey it destroyed the seed-corn, but since that time, its injuries have not been reported, nor has it as yet been discovered in the State of New York. From the rapid increase in numbers and the great multiplication in certain seasons, which the species of this family show, it is liable at any time to become, over a wide area, a serious check upon corn growing, and it is therefore important that our agriculturists should have such a knowledge of its appearance and habits as to enable them to detect its presence.

No description has yet been given of the larval form which will permit of comparison with allied species. Fig. 55 after Riley, represents its appearance, as enlarged, with a line showing its natural size. It is described as "a footless maggot, measuring 0.25 to 0.30 of an inch, of a yellowish-white color, blunt at the posterior and tapering at the anterior end." Its manner of feeding upon the corn is similar to that of the larvæ of the Onion-fly, and is represented in Fig. 56. When the corn is injured to this extent, the young shoots die, and the kernels decay. The larvæ eat rapidly and soon attain their growth, when they contract into a light-brown puparium, shown at *b*, similar to the other species of the genus. In from one week to two weeks thereafter, the fly makes its appearance. Whether there are subsequent broods of the species during the summer, and whether in the absence of seed-corn which it may feed on, it attacks some other plant, has not been ascertained.

Fig. 55. — Larva and puparium of the seed-corn fly, Anthomyia zeæ.

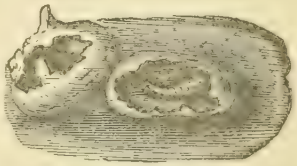

Fig. 56. — Corn as eaten by the larva of Anthomyia zeæ.

The following is a description of the fly as given by Professor Riley:—

Length 0.20 inch (5 mm); alar expanse 0.38 inch (9.5 mm). Antennæ black; style microscopically pubescent; front, fulvous, with a distinct, rather narrow, brownish, cinereous margin; face and orbits brownish-white; palpi and proboscis black; ocellar area somewhat heart-shaped; thorax and abdomen pale yellow-brownish cinereous, with minute black points at the insertion of the bristles; thorax with an indistinct middle stripe of brown; legs black, tinted with cinereous; poisers pale ochre-yellow; scales small, the upper valve larger than the lower.

This species was referred to the genus *Anthomyia* upon characters observed in two examples of the female sex, which would scarcely afford the material for positive generic reference. Baron Osten Sacken has, in his catalogue, placed it in the genus *Anthomyia* provisionally. The specific name of *zeas* originally given to it, has recently been modified by the author into *zeæ* (see references above).

Preventives.

As the harm done by this insect would usually precede its detection, it is evident that the means to be employed against it should be of a nature to prevent the attack. For this purpose, soaking the corn before planting in gas-tar or copperas water has been recommended. Any strong-smelling material that may be convenient for use would probably prevent the deposit of the eggs. Where there is reason to apprehend an attack, a small quantity of sand saturated with kerosene oil and sprinkled over the corn before covering, would, in all probability, not only preserve it from this insect, but might also protect it from destruction by grubs.

Hylemyia deceptiva Fitch.

The Deceptive Wheat-Fly.

(Ord. DIPTERA: Fam. ANTHOMYIIDÆ.)

FITCH: in Trans. N. Y. St. Agricul. Soc., for 1855, xv, 1856, p. 533: First and Second Rept. Ins. N. Y., 1856, p. 301, pl. 1, f. 3 (description).

GLOVER: MS. Notes Journ.–Dipt., 1874, p. 27, pl. 10, f. 11 (mention).

OSTEN SACKEN: Cat. Dipt. N. Amer., 1878, p. 167 (citation).

HAGEN: in Canad. Entomol., xiii, 1881, p. 49, no. 62 (in Mus. Comp. Zoöl. coll).

Our only knowledge of this Anthomyian thus far, is that obtained from the notice above cited of Dr. Fitch. It was found by him in abundance upon the heads of wheat, in the latter part of June, and received from him its specific name, from the fact that it had been commonly but erroneously believed to be the fly that deposited the eggs within the heads of wheat which produced the little yellow larvæ of the wheat-midge, *Diplosis tritici*. Nothing is known of its larva or of the habits of the fly, except that it was so numerous as to attract common attention to it, as it hovered over and alighted upon the heads of wheat at the time of their flowering.

It is described by Dr. Fitch as being "a quarter of an inch in length to the tip of the wings. It is ash-gray, with black legs, antennæ and feelers. Abdomen with a row of longitudinal brown-black spots forming an interrupted stripe along its middle. Thorax in a particular reflection of the light, showing a brown stripe anteriorly, and on each side of it a brown spot. A tawny-yellow spot upon the front, more conspicuous in the females, and passing into a black stripe upon the top of the head." It is shown enlarged in Fig. 57, after Fitch.

FIG. 57.—The Deceptive wheat-fly, HYLEMYIA DECEPTIVA, enlarged about four times, with a hind leg still more enlarged.

Two type specimens of the species, from the Loew collection, are contained in the Museum of Comparative Zoölogy at Cambridge, Mass. Dr. Hagen finds these identical with examples of *Hylemyia* from Hudson's Bay Territory, examined by Mr. Meade, and stated by him to resemble *H. antiqua* Meig. As this latter species has since been placed in the genus *Phorbia* R. Desv., it is probable, from the above comparison, that the *deceptiva* of Fitch should also be referred to that genus.

Anthomyia similis Fitch.

The Similar Wheat-Fly.

(Ord. DIPTERA : Fam. ANTHOMYIIDÆ).

Hymdyia [*Hylemyia*] *similis* FITCH: in Trans. N. Y. St. Agricul. Soc. for 1855, xv, 1856, p. 533 ; First and Second Rept. Ins. N. Y., 1856, p. 301 (description).
Hylemyia similis GLOVER : MS. Notes Journ.–Dipt., 1874, p. 27 (mention).
?*Anthomyia similis* OSTEN SACKEN : Cat. Dipt. N. Amer., 1878, p. 168 (referred with doubt to Anthomyia).

This species is represented by Dr. Fitch as about equally numerous with the preceding, and as of the same habits. It is also quite similar in appearance, whence its specific name. It is described as being somewhat smaller in size, measuring 0.22 inch in length, and of a paler shade of ash-gray. The tawny-yellow spot upon the front of the head of *Hylemyia deceptiva* is replaced in this species by black. The thorax is also without the brown stripe and spots seen in *deceptiva.*

No figure is given of the species ; and as it does not appear that it has been seen by Baron Osten Sacken, the reason of his transferring it from the genus in which it was placed by Dr. Fitch, doubtfully to that of *Anthomyia,* is not apparent. I do not know of specimens contained in any of our collections.

NOTICE OF SOME ANTHOMYIANS MINING BEET LEAVES.

During the month of August of the past year (1881), my attention was called to an unusual condition of the beet leaves growing in a vegetable garden, in Middleburgh, N. Y. The leaves were said to be infested by some insect attack to such an extent that they could no longer be served upon the table for "greens." On examination, a large number of the leaves were found to be extensively mined in blotches of various sizes and in irregular forms. Most of them had been ruptured by the escape of the miner, leaving the blotch discolored, shriveled, and in many cases torn, apparently by the subsequent growth of the leaf. Others, smooth and unbroken, showed, in elevation, the general form of an active larva feeding within.

The Larva.

On removing portions of the thin covering cuticle, the larvæ, evidently belonging to the order of Diptera, or flies, were disclosed. The date of my first observation of them was July 19th. They were then of various sizes and in different stages of growth. When taken from their mines the largest were found to be about one-fourth of an inch in length, of a watery color, showing in their transparency the intestinal canal crowded with its contents. The rings of the body were illy defined; the anterior end was produced in a point, beneath which the forked black jaws were visible: the posterior end was truncate, bearing a few small warts marginally, of which the two subdorsal (spiracular) ones were the largest. The accompanying figure of the larva is from an alcoholic specimen, which fails to show several of its characteristic features.

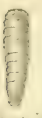

FIG. 5. Larva of beet-leaf mining Anthomyian.

Method of feeding.— It was interesting to observe, by holding an infested leaf to the light, the method of mining and the rapidity with which it was executed. The anterior end of the larva, when feeding, was extended in an acute point, from which the two black cutting organs were protruded like a pair of nippers, the motions of which were so rapid as to suggest the idea of greediness or long abstinence from food, and extreme hunger. In excavating the parenchyma, the extensile anterior portion of the larva permitted the jaws to sweep a curve of an entire semicircle.

Larvæ first observed.—The larvæ had first attracted attention within the leaves, as was learned upon inquiry, at about the middle of June. As soon as they were brought to my notice (on the 17th of July), and their interesting character ascertained, several of the largest, still

within the leaves, were collected and placed in glass jars, where their operations could be carried on under observation. Two days later, four of the number had undergone their transformation to the pupal state.

The Puparium.

The puparia (plural of puparium) average in size, from ten examples measured, 0.21 of an inch long, by 0.08 inch broad. They are of a chestnut-brown color, oval as seen from above, but somewhat elevated dorsally when viewed laterally, a little narrowed at the anterior end, the extreme front of which, under a lens, is flattened, corrugated and with a short process (the spiracle) on each side. The division into segments is barely traceable. The last segment shows from above two minute black warts (spiracles) separated by about one-third the greatest diameter of that portion. Fig. 59 *a* represents a puparium, with a line beside it indicating its natural size.

FIG. 59.—*a*, Puparium of beet-leaf mining Anthomyian; *b*, empty puparium.

The Fly.

The escape of the fly (imago) from the puparium is through its anterior end, by rupturing, usually, the three anterior segments (not counting the head) horizontally along their middle, to the junction of the third and fourth segments, and perpendicularly along this line of junction, as shown in Fig. 59 *b*. Of the two subequal pieces thus loosened, the upper one is sometimes wholly removed, but more frequently they each remain attached to the main body, at a portion of their transverse (sutural) line of fracture.

The flies observed.—While examining the leaves for larvæ, a number of flies were noticed, resting upon or walking over the plants, which so much resembled the common onion-fly that they were at once suspected to be the final form of the leaf-miners. Several of them were captured, and nearly all were found to be females (the proportion, seven females to one male), which had doubtless been drawn to the plants for the deposit of their eggs, while the males were probably feeding from the flowers of the *Compositæ* which the Anthomyids are known to frequent. Upon gently pressing the females upon the abdomen, some long white eggs were extruded, which, under a lens, showed the peculiar reticulation characteristic of *P. ceparum* and *A. betæ*, of Europe, as represented in the enlarged figures given of them in various publications. Many eggs identical with these were afterward found upon the larval infested leaves, and it was evident that the four stages of the insect had been obtained.

The Eggs.

The eggs are white, delicately reticulated, elongate-elliptical in form, 0.03 of an inch in length, and about one-third as broad (.075 mm. by .024 mm). Their general appearance is shown in Fig. 60.* They are placed by the fly on the under surface of the leaf, with few exceptions, — sometimes singly, most frequently in twos attached by their sides, often in threes, occasionally in fours, and in a very few instances, five were seen together. Upon one leaf, during the latter part of July, when the eggs seemed most abundant, thirty-seven were counted, of which about one-third had given out their larvæ or had been killed. They were distributed over the entire surface of the leaf, but rather more numerously toward the margin. A leaf free from eggs could rarely be found.

Fig. 60. — Eggs of an Anthomyian, greatly enlarged.

The Mines.

When the egg hatches, the young larva enters at once into the leaf. Its burrow is at first quite narrow, scarcely exceeding the diameter of the egg-shell, but it soon enlarges, and after proceeding a short distance, expands into an irregular blotch. When two or more eggs are placed side by side, the larvæ occupy the same burrow and the same mined cavity. Their channels usually lead toward the outer edge of the leaf and extend to the margin, where the mined portions, after their abandonment by the mature larva, become dried and present the appearance before described. Occasionally, the larvæ find themselves so crowded in one portion of a leaf as to interfere with their food-supply, when some of the number emerge from their circumscribed quarters and travel to other parts of the leaf, or to another leaf, where they quickly gnaw through the epidermis and burrow beneath it. In one instance in which the operation was watched by me, the larva (a large one) had entirely hidden itself in fifteen minutes.

The Flies from Pupæ.

On August 7th, four of the flies emerged from pupæ, which had been obtained from the larvæ about two weeks before. On the 8th, several of the infested leaves were gathered, and portions cut from them containing about twenty-five of the larvæ nearly full-grown. These were placed in a glass jar of loose earth, and as the material was eaten, or became unfit for food, as it speedily did, fresh pieces were supplied. As

*The eggs of these species are longer than those shown in the figure; the reticulations also are longer and less regular, so that while their general shape is hexagonal, others are but four-sided and of the form of a parallelogram, and others still of irregular form with four, five or six unequal sides.

the larvæ matured, they left their mines and entered the earth for pupation, except in a few instances in which the puparia were formed between the leaves. On the 26th of August, ten flies were found in the jar, some of which were dead. It had not been possible to note the earliest date of their emergence, and the period of their pupation was therefore not ascertained. It will probably be found not to vary much from two weeks.

Successive Broods.

There are two or more broods of these flies annually, for at the date of leaving the locality where the above observations were made — September 6th, — the eggs were still numerous upon the leaves, although less so than in July. Their examination showed, however, that the larger number had been destroyed, perhaps by some insect puncturing them and feeding upon their contents. Of some, the entire flattened shell remained, while of others, portions had disappeared. It is possible that toward the close of the season, many of the eggs may be deposited without fertilization.

Three Species of Flies.

While rearing and collecting the above flies, I believed them to be but a single species. From the food-plant on which they occurred, and from reference to the very limited Dipteralogical literature accessible at the time, I thought them identical with the European species, *Anthomyia betæ*, of Curtis.* It seemed an interesting coincidence that while the past year had developed extensive injuries to the beet-crop in England, from the attack of this species which had remained almost unknown since its publication in 1860,† it should at the same time first present itself to us in this country.

Later, upon closer observation and critical comparison, I discovered material differences among my examples, which appeared to indicate three species. Knowing the worthlessness of determinations between the closely allied species of this family not based on special study, I

*Anthomyia (Pegomyia) betæ. The *males* are only known at present; they are much smaller than the Onion-fly, being only 2 2-3 lines long, and expanding about five lines: they are of an ashy-gray color, clothed with black bristly hairs; head semi-orbicular; eyes large, brown, nearly contiguous above, with three minute ocelli on the crown; face satiny-white, with a bright chestnut-colored line down the middle, in the center of which are placed the little black drooping horns, the third joint being the largest, elliptical, and producing a naked bristle on the back; the protruding lips and palpi are also black; on the trunk are three or five indistinct longitudinal stripes; the six-jointed abdomen is linear, with a dorsal, black triangular spot at the base of four of the segments; the two wings are ample and transparent, a little tinted with tawny at the base; the nervures are pitchy; poisers ochreous; six legs, longish, bristly and pitchy, the shanks with a tawny tinge. (*Farm Insects*, 1860, p. 397.)

†*Canadian Entomologist*, xiv, 1882, p. 96.

sent the specimens to Mr. R. H. Meade, of England, for his decision. He kindly returned me answer that the examples submitted to him belong to three different species, as supposed, but that "neither corresponds with the *Anthomyia* (*Chortophila*) *beta* of Curtis (*sulcans* Rondani), the distinctive characters of which* are to have the femora all black in the male (posterior often testaceous in the female), as well as the tarsi, tibiæ all testaceous or piceous in both sexes; antennæ entirely black; palpi yellow with black ends."

One of the species was found to be identical with an European one, and it may therefore have been introduced in this country from Europe as among the many species which are common to the two continents, a number, doubtless, are of European origin. The species is given below.

Phorbia floccosa (Macq.) Meade.

Musca floralis? of FALLÉN, MEIGEN, ZETTERSTEDT, SCHINER, *et al.*
Chortophila floccosa MACQUART: Hist. Nat. des Insectes — Diptères, 1835, ii, pp. 326–7.
Chortophila floccosa. MEADE: in Entomol. Month. Mag., xiv, 1878, p. 252.
Chortophila floccosa. LINTNER: in Canadian Entomologist, xiv, 1882, p. 96.
Phorbia floccosa MEADE: in Entomol. Month. Mag., xix, 1883, p. 214.

In identifying this species, Mr. Meade states that it has been found in England by Mr. Inchbald, feeding in the larva state upon the roots of cauliflowers. It was the first time that it had been brought to his notice as a leaf-miner. He also writes of it: "I see that I noticed one male specimen of this species in the collection of *Anthomyiidæ* sent to me from the Cambridge (Mass.) Museum." In the paper here referred to (*Canad. Entomol.*, xiii, p. 49), the determination of the species is doubtfully given, thus: "74. Very similar to *C. floccosa* Meig., 1 male, Mass." We infer from the above, that the examination of these additional examples has satisfied Mr. Meade of their identity with the one first seen.

The specific name of this species refers to a little tuft of hairs like a flock of wool under the base of the hind femora in the male. This sex may be readily recognized by this feature, and by the additional one of "the inner sides of the hind tibiæ being ciliated along the middle part of their inner surfaces with a series of short bristles of unequal length." The original description by Macquart, above cited, kindly transcribed for me by Professor Riley, is as follows:—

Length, 3 lines. Palpi and antennæ black. Face and sides of occiput whitish; frontal band black. Thorax dingy-gray with blackish lines. Abdomen cinereous

*These are mainly in addition to those given by Curtis above (differing in the color of the palpi), who only describes the male.

with a black dorsal line and black sutures. Legs black; posterior thighs with rather short hairs, tufted near the base. Alutæ yellowish. Wings slightly brownish; second transverse vein somewhat oblique and arched.—From the North of France.

As these pages are passing into the hands of the printer, a paper by Mr. Meade has been received in which the above species is noticed, and some additional facts in relation to it given. It was reared in England last summer from cabbage-plants which were represented as infested with the "grubs of the cabbage-fly." If the very probable identity of the species with *Musca floralis* is established, then, according to Zetterstedt and Schiner, it also embraces in its food-plants the radish (*Raphanus sativus*).

Chortophila betarum n. sp.

Four examples of this species — one male and three females — were among the material submitted to Mr. Meade. They were unknown to him, and believed to be undescribed. I therefore give them a name, and present the following description:

Smaller than *P. floccosa*, and of about the size of *C. betæ;* the average expanse of wings of five examples is 0.4 inch. The thorax and abdomen are gray, intermediate in shade to *P. floccosa* and *C. betæ*. The thorax has a broad dusky mesial stripe with a narrower one on each side, while the abdomen is without line or spots. In the male, the narrow front of the head is silvery-white. In the female, the space between the eyes is broad, exceeding one-third the width of the head; the frontal band is black, except a crescentiform portion just above the antennæ, which is red; the lateral borders and front beneath is whitish; the bristles of the borders are quite stout; the arista is hairy to the tip, the hairs rather long; the antennæ and palpi are black. The wings are more rounded apically and less prolonged than in the associated species (form and venation shown in Fig. 61); slightly brown in color; the costal margin distinctly spined from the base to the axillary vein, with the two spines anterior to the latter point but slightly exceeding the others in length.* The legs are black; the hind femora and tibiæ with strong bristles.

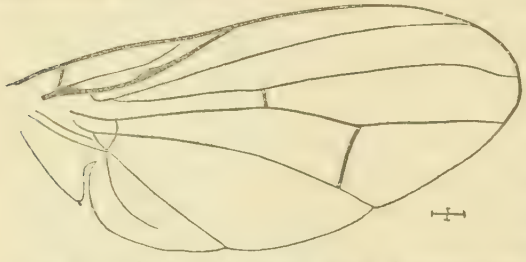

Fig. 61.— Wing of a beet-leaf miner, Chortophila betarum; enlarged 15 diameters.

Described from eight examples — 2 ♂'s and 6 ♀'s.

P. floccosa has these spines strong and long — the outer one the longer.

This species has also been reared by Professor Comstock, at Ithaca, in a single example, which emerged from pupa after twenty days' pupation.

Pegomyia vicina n. sp.

Of the examples of this form, Mr. Meade writes: "They are males of a species very similar to Fallen's *Musca* (*Chortophila*) *conformis*. Fallen, however, as well as Zetterstedt, only knew the female, which has the femora all yellow as well as the basal joints of antennæ, etc., as in your specimens. I have, however, this last summer, obtained both males and females of *conformis*, bred from the leaves of *Arctium lappa* [burdock] which they mine, and the males have the antennæ quite black, and also the anterior femora, so that they differ in these respects from your species."

From its close resemblance to *conformis*, this species may be designated as *vicina*. Three examples of it — all males — were among the specimens obtained by me from the mined beet-leaves. The following is briefly its description :—

Head with a few black bristles, front whitish, with the frontal stripe pale reddish-brown ; antennæ black, first joint yellow ; arista with very short hairs under a strong magnifier; palpi yellow, black at tip. Thorax cinereous, inclining to yellow, bristly, faintly lined, with a broad mesial and narrower lateral brownish stripes, and spotted laterally with brown. Abdomen subcylindrical, color of the thorax, with a mesial blackish spot on the anterior half of each segment; hairs black, arranged in five transverse rows, of which those of the hinder row are long; five segments seen from above, the appendages recurved beneath. Poisers yellow. Legs moderately hairy, the femora and tibiæ yellowish, the tarsi black, middle femora more hairy beneath, with four long bristles near their base; the, posterior femora and tibiæ with numerous stout black bristles. Wings slightly tinged with brown, quite iridescent, the two longitudinal veins 3 and 4 parallel toward the margin, and diverging at it, and the hinder transverse vein (9) quite angulated. Fig. 62, represents the venation of the species

Expanse of wings, 0.48 inch.

Described from two males disclosed from pupæ, August 7th.

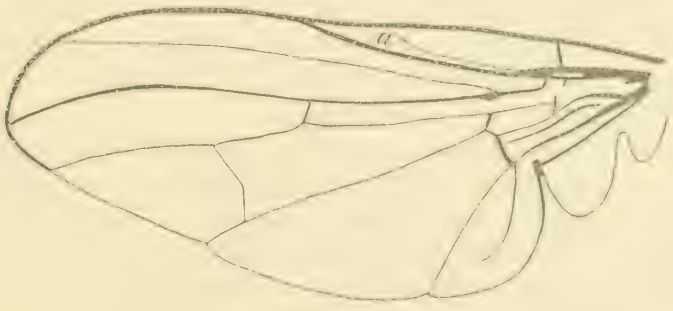

FIG. 62.— Wing of a beet-leaf miner, PEGOMYIA VICINA, enlarged 15 diameters.

During an absence of several days (Aug. 15–25) from Middleburgh, where these collections were made, a number of the flies emerged within the covered boxes in which the larvæ had pupated, and on my return they were found dead and badly injured by the mold that had attacked them and partially encased them in earth. From the material taken from the box at this time, the best portion of which was laid aside for subsequent examination, I am able to distinguish five males and three females of the above species, but from their poor condition, they can only serve the purpose of verification of the above description. This species was therefore obtained in larger number from the mined beet-leaves than either of the two others.

This species also occurs, in similar depredations in Central New York. Beet-leaves, in Morrisville, were observed during the summer to be extensively mined, and it was thought that the insect infesting them had caused sickness in several instances in persons who had eaten them for "greens." Through the kindness of Professor J. H. Comstock, in submitting to me three examples of *Anthomyiidæ* which he reared from the puparia of some of the leaf-miners sent to him, I am able to recognize this species, and as it happens to be a female, to give herewith its distinctive features :—

Female P. VICINA. In color paler than the male, approaching an ash shade. The frontal band of the head is whitish, equal in width to one-third the diameter of the head, with six black bristles in each lateral margin, of which the three upper ones are directed outwardly, and the three lower inwardly. The body is narrowly oval, and its hairs are shorter than of the male ; the terminal segment bears at its tip a transverse row of six long black bristles.

The puparium (as per notes of Professor Comstock placed in my hands) was received, with three others, July 25, 1881, and was believed to have transformed the previous day. It gave out the fly on August 16th, making a pupal period of twenty-two days.

A feature in the venation of this species which distinguishes it from other of its associated species examined by me, is the great constriction of cell *a* (shown in Fig. 62) at the point of thickening of the vein below it (the 1st longitudinal). In the other example of the male in my possession, the cell beyond this point toward the base, is quite obliterated — the two veins being contiguous.

The work of these leaf-miners was also observed by me during the present year, at Bennington, Vt., in a single garden, while it was not found in other gardens where search was made for them. Infested leaves were gathered and a few puparia obtained, but, as they did not produce the fly, the species could not be determined — these Anthomyiæ puparia showing but few features of specific value.

It is not improbable that many of our *Anthomyiidæ* will hereafter be found operating as leaf-miners. I can recall, in former years, meeting with miners within the leaves of various succulent plants, of which the mines were so much like those of the above described species, that there can be but little doubt that their rearing would show them to belong to the same group — perhaps to the genus *Pegomyia*, embracing so many of the leaf-mining Diptera of Europe. Mr. D. W. Coquillet, of Anaheim, California, has informed me that during the past season, he had bred from mines in the leaves of a wild sunflower (*Helianthus* sp.?), several dipterous insects belonging apparently to the *Muscidæ*. They were probably Anthomyians.

Mallota posticata (Fabr.) Wlstn. MS.

(Ord. DIPTERA : Fam. SYRPHIDÆ.)

Eristalis posticatus Fabr : Systema Antliatorum, 1805, p. 237, no. 21. Non *M. posticata* (Fabr.) of Osten Sacken : Cat. Dipt. N. Amer., 1878, p. 135 (= *M. cimbiciformis* (Fallen) Wlstn. MS.) ; non id., Bull. Buff. Soc. Nat. Sci., iii, 1875, p. 58 (= *M. cimbiciformis* var. *dentipes* Wlstn. MS.); non id., Western Diptera, in Bull. G.-G. Surv. Terr., iii, 1877, p. 338 (=*M Sackeni* Wlstn.).

Milesia barda Say : in Journ. Acad. Nat. Sci. Phila., vi, 1829, p. 163 (not the ♀).

Eristalis coactus Wiedemann : Aussereurop. Zweiflüg. Ins., ii, 1830, 165 ; Ib , p. 194, no. 62 (*E. posticatus*, translation from Fabr.).

Imatisma posticata Macquart : Diptères Exotiques, 1840, ii, p. 2, no. 68 (♂ only).

Merodon balanus Walker : List Dipt. Ins. Br. Mus., iii, 1852, p. 599.

Merodon bardus Packard : Guide Study Ins., 1869, p. 399, fig. 319 ; in Amer. Nat., ii, Jan. 1869, p. 593, pl. 12, figs. 10, 10 *a* (imago and puparium).

Merodon bardus Glover : MS. Notes Journ.— Dipt., 1874, p. 32, pl. viii, f. 30.

Mallota barda Osten Sacken : in Bull. Buff. Soc. Nat. Sci., iii, 1875, pp. 58, 64 ; Cat. Dipt. N. Amer., 1878, pp. 135, 249.

Mallota posticata (Fabr.). Williston : MS. Monograph of the Syrphidæ, 1883.

The Family of Syrphidæ.

The *Syrphidæ*, the name of the family to which this species belongs, are commonly known by the name of *flower-flies* from the habit of the perfect insects of frequenting flowers for the purpose of feeding upon the pollen* and the nectar. They fly with great rapidity, and may often be seen hovering in the bright sunshine, for a long time almost immovably, upon their rapidly vibrating invisible wings. The family

*Although entomologists have expressed a doubt as to whether it was possible for insects possessing only a suctorial proboscis to devour such solid bodies as pollen-grains, a microscopic examination of the stomach of Diptera belonging to the order of *Syrphidæ*, showed them to contain large quantities of pollen-grains, especially of plants belonging to the order of *Compositæ*. (*Science Gossip*, for 1873, p. 41.)

is a very large one, containing no less than fifty-seven North American genera and three hundred and thirty-six species, as given in Osten Sacken's catalogue.* Many of them are conspicuously marked with brown and yellow bands or spots upon their flattened bodies. While many are smooth, others, as in the genera *Volucella, Eristalis, Helophilus* and *Mallota* are hairy, and often from their colors and hirsuteness so strongly resemble bees that they are not infrequently mistaken for them. The larvæ of many species are of eminent service in destroying plant-lice (*Aphides*), among which the parent Syrphus deposits her egg, where the young larvæ, which are destitute of eyes, have only to reach out with their extensile bodies in order to find their prey. Several species of *Eristalis* and others are aquatic, living during their larval stage in the water, where they burrow in the mud, and breathe through a long respiratory tube with which they are provided, which they protrude from the water for the reception of air. Other species (*Volucella*) occur in the nests of bees and wasps where they feed upon the larvæ and pupæ. Still others are found in decaying wood, in vegetable mold, in the soil about decaying bulbs, and in the filth of cess-pools.

A Strange Location for the Larvæ.

Dr. Packard, in his brief notice of this species, under the name of *Mallota barda*, states that "the puparium or pupa-case closely resembles that of *Eristalis*, in possessing a long respiratory tube, showing that the maggot undoubtedly lives in the water, and when desirous of breathing, protrudes the tube out of the water, thus drawing in air enough to fill its internal respiratory tubes (tracheæ)." The long breathing-tube would seem to be a fitting provision for such a mode of life, moreover, it is almost identical in appearance with the figure given by Glover (*MS. Notes of Diptera*, pl. 7, f. 28), of *Helophilus tenax*, now included in the genus *Eristalis*, which is generally regarded as aquatic. The conditions, however, under which the larvæ occurred from which I bred the perfect insect, render it probable that the present species is not aquatic. They were taken from a birch tree which stood on a knoll, twenty-five to thirty rods from the nearest water. At about thirty feet from the ground a limb had been broken off, and water had been admitted, causing a decay in the heart-wood for about three feet in extent. From this decayed material the two larvæ (together with others of different character which were not preserved) were taken and sent to me, in the fine black mold in which they were buried. The tree-trunk elsewhere was perfectly sound.

*Six genera and a number of new species have since been added. See "Contribution to a Monograph of the North American Syrphidæ," by Dr. S. W. Williston, in *Proc. Amer. Philosoph. Soc.*, 1882, xx, pp. 299-332.

The natural inference from the above statement, as communicated to me, is that the larvæ were found in the tree at the time when it was cut. Such a location for one of these peculiar larvæ would seem so different from their usually assigned aquatic habitat, that the possibility is suggested that the tree may have lain upon the ground sufficiently long before its examination to have allowed the larvæ to have entered the prostrate trunk while searching for a place for pupation. But as tending to confirm a larvation of some of these species in the mold of decaying portions of standing trees, we have the following observations made at Berlin, Conn., by Mr. N. Coleman, of another species of these curious forms : —

A singular place for Rat-tailed Larvæ.— I found several of these curious larvæ in a branch of an old apple-tree that had just been cut down. They were below a large nest of black ants, who had honey-combed the branch for quite a distance. They were twenty-five millimeters long when crawling, not so much when at rest, wrinkled and ridged rather remarkably, the tail a little longer than the body and tipped with a row of bristles curved backward. (*Psyche*, ii, 1878, p. 154.)

Habits of Rat-tail Larvæ.

These species belong to a class which Réaumur called "vers à queue de rat," and which are now commonly known as *rat-tail larvæ*, from the long tail-like appendage to their body, consisting of two tubes, one of which can be drawn into the other like a telescope, through which air may be inhaled from the surface of the water when the body is buried in the mud beneath. Réaumur found, in some examples experimented with, that the tail terminated in a little knob, perforated by two holes for the reception of air, and having five little tufts of hair which floated on the water. Having placed some specimens of them in a basin of water, he saw that "they kept in a perpendicular position at the bottom, and parallel to one another, the extremities of their tails being on the surface. He then increased the depth of the water by degrees, and as it got deeper, observed that the tail of each worm became longer. These tails, which at first were only two inches long, at last attained to five."

Description of the Mallota Larva.

The examples received by me about the middle of January were sordid white or flesh-color, with a body of an oval form, about three-eighths of an inch in length by about one-fourth of an inch when at rest, and about twice as long and of a diminished diameter when in motion. From the narrower end a tail-like projection is given out, an inch in length, which is slightly tapering and transversely wrinkled for two-thirds of its length ; the remainder being a black, cylindrical, bristle-like process, which is susceptible of projection from, or contrac-

tion within, the anterior portion. When the grubs were taken from the mold, they extended their front segments like the pushing out of an introverted glove-finger, and made a moderate degree of progress over the paper on which they were placed, by the aid of several pairs of small, low, flattened ventral tubercles, bearing on their circumference a number of closely-set, radiating spinules — these organs serving the purpose of legs.

From the fact that the larvæ did not go into pupation until about a month after their reception, it may be presumed that during this time they fed upon the mold in which they were buried. If this be so, then it does not seem necessary to doubt that the place in which they were discovered was that in which their earlier larval stage had been passed.

Pupation.

Several times between February 9th and 13th, the larvæ emerged from the mold, and traveled restlessly about the jar in which they were confined, as if seeking a more agreeable or suitable retreat. Finally they remained upon the surface, being no longer able to bury in the mold. On the 16th of February it was evident that their pupal change was in progress. They had contracted materially in size, and become more pointed behind. The front segments assumed a darker shade, and of these the first two segments were of a blackish color. The two respiratory horns on the dorsum over the second pair of leg-tubercles had become more prominent, and were now about one-twentieth of an inch long. The tube containing the respiratory seta was dark brown. An irregular-shaped packet of excremental matter was attached to the anal orifice.

Fig. 63.— Puparium of Mallota posticata.

The pupation was brief — twelve days in one example (a male), and fourteen in the other (a female). The flies emerged from their pupal cases, which were left as thin shreds within the puparia, by rupturing the latter in a line above the mouth-parts and again just back of the respiratory horns, and forcing off an oval piece : in one example the horns continued attached to the puparium.

The Puparium.

Fig. 63 represents the puparium as seen from above, in double its natural size. The respiratory tube is clearly seen to consist of three portions, of which the main part is more corrugated and granulose than shown in the figure. Laterally, seven slightly projecting black spiracles may be seen with a lens—one over each leg-tubercle. Ventrally

between the tubercles are transverse rows of bristles, and outside of the tubercles are longitudinal rows, which evidently are of service in locomotion. The body-portion of the puparium is flattened beneath and rounded above. The respiratory horns as figured, are somewhat foreshortened, and are not, therefore, shown in their full length.

The Fly.

The flies emerged, in a warm room, on February 27th and March 1st. Fig. 64 represents the male, in twice its natural size. The wings are transparent, without spots. The body is black; the thorax is covered with yellow hairs, which are sparsely distributed centrally; the first (basal) segment has similar hairs on its sides and base. The female differs in having the thorax, entire basal segment, and base of second entirely covered with yellow hairs, and a small brown spot* on the anterior central portion of the wing. We give herewith Say's description of it, as *M. barda:*

Body black; *hypostoma* with silvery hairs and longitudinal, polished, naked line; *antennæ* piceous; *front* covered by yellow hair; *thorax* densely covered by yellow hair, black in the middle; *scutel* piceous covered by yellow hair; wings with a large fuscous spot on the middle, obsolete in the male; *poisers* piceous; *tergum* black, covered by black hairs; basal segment and second segment at base covered by yellow hairs; *feet* hairy; *tarsi* piceous; posterior thighs of the male much thickened and with their tibiæ arquated.

FIG. 64.—MALLOTA POSTICATA; twice the natural size.

Length 3–5 of an inch. Inhab. Indiana.

Dr. Packard, represents the fly as a common species and "frequently met with." I have never taken it abroad. Dr. S. W. Williston, of New Haven, has found it rather common in Connecticut, in the month of June, about the blossoms of blackberry and dogwood, in company with *M. cimbiciformis* (= *M. posticata* of Osten Sacken's Catalogue). He had also received it from Canada and Kansas. Localities given for it (*M. barda*) by Baron Osten Sacken, are Catskill, N. Y., Massachusetts, and the White Mountains, N. H.

My specimens were determined by Mr. E. Burgess, as *M. barda*, by comparison with the original types of Say, preserved in the Harris collection, in the Museum of the Boston Society of Natural History.

*Osten Sacken's note, No. 226, on page 249 of the Catalogue of Diptera, in which he states that "the brown spot on the wings of the females mentioned in Say's description does not exist in the real female of *M. barda*," might convey the impression of the entire absence of a spot. Say's mention is that of a large fuscous spot. The spot is small and obscure, and is not a conspicuous feature.

In its reference to *M. posticata*, I have accepted the conclusions reached by Dr. Williston, as a result of his recent studies of the Mallota species — kindly given me in advance of publication in his nearly completed *Monograph of the Syrphidæ*.

Drosophila ampelophila Loew.

The Pickled-fruit Fly.

(Ord. DIPTERA : Fam. DROSOPHILIDÆ.)

Loew : Dipt. Amer. Sept. indig. : in Berl. Ent. Zeit., Cent. ii, 1862, no. 99, p. 101 (original description).

Osten Sacken : Cat. Dipt. N. Amer., 1878, p. 205 (cited, with localities).

Lintner : in Count. Gent., lxv, 1880, p. 7 (general notice).

Bowles : in Canad. Entomol., xiv, 1882, pp. 101–104, figs. 10, 11 (description, habit, etc.).

Williston : in Canad. Entomol., xiv, 1882, p. 138 (habits).

Comstock : in Ann. Rept. Commis. Agricul. for 1881–1882, (1882), pp. 198–201, pl. 15, figs. 1–8 (detailed account).

Some examples of a small fly were sent to me during the month of December, with the statement that "they had been taken from a pan of decaying peaches, and on opening some of the softest, they were found filled with small white maggots. What was believed to be the same kind of maggot had been found at different times in a jar of sweet jam and in one of sour pickles, while the same flies were abundant around them."

The Fly Described.

The flies were about one-eighth of an inch long, with a large rounded thorax, the head and legs of a yellowish color, and the broad wings (form and venation, shown in Fig. 65) iridescent, with shades of green, purple, etc. They proved to be identical with numerous specimens of *Drosophila ampelophila* in my collection, having the memorandum of "bred from a jar of pickled plums, September, 1875." They had been determined for me by Baron Osten Sacken, to whom I had communicated some of the examples, and he has also, as I learn from Dr. Hagen, placed specimens of the same, labeled as above and with the above memorandum, in the collection of the Museum of Comparative Zoölogy, at Cambridge.

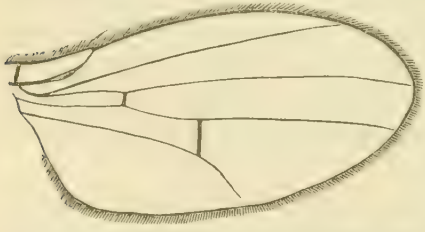

Fig. 65.— Wing of the Pickled-fruit Fly, Drosophila ampelophila; enlarged 25 diameters.

As the original description of this species by Dr. Loew is published in Latin, in a work to be found in very few of our libraries,* I give herewith its translation: —

"*Drosophila ampelophila n. sp., ♂ and ♀. From pale yellow to rufescent, antennæ pallid, abdomen marked with black bands, the last two segments in the male, the last one in the female, jet-black, a jet-black apical point on the anterior metatarsus of the male, wings wholly without spots. Length of body* 3-4 to 5-6 *line. Length of wing* 5-6 to 11-12 *line.*

"Front pale yellow, opaque. Antennæ pallid, the third article sometimes slightly fuscous. The prominent face pale yellow, with several rather stout beard-bristles on each side. The back of the thorax from pale yellow to rufescent, uniform in color, moderately shining. Scutellum of the thorax the same color. Pleura more pallid. Abdomen from pale yellow to rufescent, each segment girt with a posterior black band which is sometimes dilated on the middle segments, the last two segments in the male jet black, the last one in the female black or dark fuscous. The feet yellowish; the anterior metatarsus of the male has a minute jet-black tubercle on the upper side at the apex. Wings short, rather broad, from cinereous to somewhat yellow, wholly unspotted, the transverse veins not distant from each other. (Cuba; Poey.)

"NOTE.— *Drosophila ampelophila* is very frequent in the southern regions of Europe, nor is it entirely wanting to Middle Europe; it also inhabits the southern parts of Africa."

The species will undoubtedly be found to have quite a general distribution over the Western, as in the Eastern Continent. Mr. Bowles has found it in Montreal, Canada. Dr. Williston records it in the New England States in Massachusetts and Connecticut, in great abundance in August, September and October. It occurs in Pennsylvania (Bowles), and District of Columbia and Cuba† (Osten-Sacken). It may be expected to be found in South America.

Attracted by Fermentation.

The specific name of this species signifies *a lover of the vine.* It may have originally been discovered on grapes,‡ or a more liberal translation of its name might indicate a lover of substances undergoing a vinous fermentation. As it has already been observed within decaying peaches and pears, injured grapes, and pickled plums and raspberries, it is probable that it will hereafter be found associated with a large number of fruits, berries, and perhaps garden vegetables also, undergoing fermentation, either through pickling, injury or decay. Dr. Williston (*loc. cit.*) writes of them: "Perfectly sound fruit I have

*I am indebted to Professor Riley for its transcription from the volume in the Congressional Library at Washington.

†Dr. Loew's types, from these two localities, are in the Museum of Comparative Zoölogy at Cambridge, Mass.

‡Examples of the fly have been sent to me from Rev. Samuel Lockwood, of Freehold, N. J., with the statement that the insect had infested his ripe grapes during the autumn of 1881. An account of its attack and of its life-history is promised.

never known to be attacked by them, but the slightest indication of fermentation attracts them in great numbers, and about heaps of cider refuse I have seen them in clouds."*

The Larvæ.

I have not observed the larva of this species. Mr. Bowles (*loc. cit.*) gives this account of it: "The larvæ, when full grown, are nearly one-fourth of an inch long, somewhat tapering toward the head, which is small, and are sparsely covered with minute hairs, particularly on the divisions of the segments. They have no feet, but can travel quite rapidly on glass, seeming to retain their hold by a glutinous condition of the skin, and moving by extending and contracting their bodies. They seem to exist with ease either in the vinegar or the air, moving through the former in search of food, and sometimes coming out of it, and either resting or moving about on the sides of the vessel. Their bodies were quite transparent, and under the microscope, their internal organs could easily be seen. At both ends of their bodies are curious projections or tubercles, which are also seen in the pupa. The puparium is about three-sixteenths inch long, oval in shape, and yellowish-brown in color, with the tubercles at head and tail before referred to."

A jar of pickled raspberries prepared for raspberry vinegar, opened about ten days after it had been put up, was found to be swarming with hundreds of the larvæ, crawling on the sides of the jar and underside of the cover, while numbers of pupæ, singly and in clusters, were found near the cover of the jar. The pupal state lasted ten or twelve days.

Other Species of Drosophila.

Twenty-five North American species of *Drosophila* are catalogued, which have all, with the exception of three species† common to Europe and America, been described by Dr. Loew, the distinguished Prussian Dipterist (lately deceased), and Mr. Walker of the British Museum. They have not been studied by our American entomologists, and consequently nothing is known of their habits. I find no reference to a single determined species by any of our writers.‡

Apple-infesting Drosophilas.

In the *American Naturalist*, vol. ii, p. 641, an unknown species of

*At Bennington, Vt., in August of the present year (1882), I saw beneath pieces of boards lying upon a large patch of decomposed cider refuse of last year, numbers of what was thought to be this species, but the examples taken were lost before comparison could be made.

†*Drosophila funebris* Meigen, *D. graminum* Fallen, and *D. transversa* Fallen.

‡See Note upon page 221.

Drosophila is noticed as infesting apples, preferring the earlier varieties. The larvæ enter the apple usually where it has been bored by the apple-worm (*Carpocapsa pomonella*), and sometimes through the calyx. They penetrate its interior in every direction, and if several are working together, as is sometimes the case, they render it quite unfit for use. Apples that appeared perfectly sound when taken from the tree were often found to be "all alive" with them after having been kept a few weeks. The writer of the communication referred to, had frequently observed the pupæ in the bottom of barrels in a cellar in the winter, from which the flies appeared in the spring. Dr. Packard, in his *Guide to the Study of Insects*, p. 415, figures an unknown species of *Drosophila* as the "apple-fly," which is believed to be the above species. The larvæ, of which a brief notice is given by Walsh, in vol. ii of the *Practical Entomologist*, page 20, were probably those of a species of *Drosophila*. They are described as nearly one-fourth of an inch long, of the diameter of a common pin, without legs, the color of the pulp of an apple, and with a black mark on the top of the head. They had injured an apple crop in the State of Vermont to the extent of about one-half its value by boring the fruit in every direction. They had also proved similarly injurious to apples on Long Island. On page 55 of the same volume, other "apple-worms" are noticed, which had been received from Massachusetts, which may have been of the same species, although there are discrepancies between the descriptions given of the two.

The above "apple-worms" should not be confounded with the larvæ of the apple-midge, *Molobrus mali*, of Dr. Fitch (*First and Second Reports*, page 252), which also destroy the interior of the apple, while the exterior is without blemish with the exception, usually, of the perforation of the Carpocapsa apple-worm, through which, it has been thought, the midge larvæ effect their entrance. This little species, now known as *Sciari mali*, belongs to a family quite far removed from the *Drosophilidæ*, viz., the *Mycetophilidæ*.

Strawberry Drosophila.

Larvæ, stated to be a species of *Drosophila*, have been found within strawberries.* They were gathered quite late in the season, after they were no longer offered in market; and as all were infested with the larvæ, it is not improbable that the flies may have been attracted to them through an incipient fermentation of the juices of the later berries.

The different species of *Drosophila* vary considerably in their habits, as we learn from European writers; and indeed the same species seems

**Field and Forest*, ii, 1876, p. 102.

often to occur under apparently quite different conditions. The larvæ of the European *D. cellaris* occur in fermented liquids in cellars, as wine, cider, vinegar and beer, and also in decayed potatoes. *Drosophila aceti* Kol., infests decayed fruits. Its larvæ occupy about eight weeks in attaining their growth, and their pupal state lasts for ten or twelve days; the flies appear in May and June. *Drosophila funebris* has been reared from pupæ taken from mushrooms; it is sometimes known as the vinegar fly. Another European species, the *D. flava*, is stated by Curtis, to mine the leaves of turnips, raising blister-like elevations on their upper surface.

Flour-paste Drosophila.

A species of *Drosophila* seems to occur occasionally in flour-paste. A gentleman wrote me as follows: "I send a package containing larvæ of a fly very troublesome around my cellar and pantry. These I found in a little paste that I had set aside for a short time. I could not obtain the flies, but presume that they will be produced from the larvæ. They are very partial to any thing in a state of fermentation, and if my pickled fruit or jam begins to sour, they find it before I do, and frequently the entire top of the fruit seems alive with the larvæ, although they never go deep in the jar."

The paste larvæ formed puparia one-tenth of an inch long, which in a short time gave out flies having a spread of wings of one-eighth of an inch. The large thorax and small abdomen are dull yellowish in color, and under a lens show a number of long, stout hairs; the wings are brilliantly iridescent. These flies are probably an undescribed species of *Drosophila*, and may be presumed to be different from those above mentioned as infesting the pickled fruit and jam: it is not improbable that the latter were *D. ampelophila*.

Mode of Attack upon Pickled Fruits.

As our pickled fruits are usually preserved in large earthen or glass vessels which are opened from time to time for the removal of a portion of the contents, the escaping acetic odor which they give forth, readily attracts the Drosophila flies which are to be found in our houses during the early autumn. The minute fly effects an entrance into the jar beneath a loosely-fitting lid, and deposits its eggs upon the fruit, if accessible, or upon the side of the jar, whence the young larvæ instinctively, when hatched, make their way to the fruit, or find their needed sustenance in the liquid in which they are sometimes seen to swarm. Or, with a more closely-fitting lid, the eggs may be deposited upon the outer edge, beneath which the newly-hatched diminutive larvæ insinuate themselves without material difficulty.

In a species of *?Drosophila* which has recently been under my observation, occurring in a jar of mustard pickles, the larvæ, when nearly full grown, left the liquid and passed to the side and top of the glass jar in which I had placed them, where they could be observed in feeding upon the condensed moisture, and in comparatively rapid movement over the surface. Here they transformed to puparia, from which the first fly emerged in four days.

Preventives.

If a cloth or paper charged with some substance, the odor of which would overcome the acetic odor, be placed underneath the lid, if practicable, or if not, tied over it, and the exterior of the jar kept entirely free from acid, the contents of the jar will not be attacked. The flies would not be drawn to the jar for the deposit of their eggs. For the above purpose, tarred paper, such as is sometimes used for preserving merchandise from wet, would probably prove effectual. Paper steeped in strong carbolic-acid water or in soluble phenyle might be serviceable, or any strong and permanent odor might be thus used.

NOTE.— Since the writing of the preceding notice, an advance copy of the Report of the Entomologist of the U. S. Department of Agriculture, Prof. C. V. Riley, for the year ending June, 1882 [issued Oct. 13, 1882], has been received through the kindness of the author. In it is contained an account, by Professor Comstock, of the early stages of *Drosophila ampelophila* — the egg, larva and pupa — with references to a plate of several figures, illustrating structure, etc., not yet issued. A second species of the genus, *Drosophila amœna* Loew, the larvæ of which, like those of *D. ampelophila*, were reared from decaying apples, is also described and has been figured in its larval, pupal and perfect states.

Meromyza Americana Fitch.*

The Wheat-stem Maggot.

(Ord. DIPTERA: Fam. OSCINIDÆ.)

FITCH: in Trans. N. Y. St. Agricul. Soc. for 1855, xv, 1856, p. 531; First and Second Rept. Ins. N. Y., 1856, p. 299.

RILEY: in Rural New Yorker for Jan. 28, 1869, p. — ; First Rept. Ins. Mo., 1869, pp. 159–161, fig. 90, pl. 2, f. 28 (depredations, transformations, description, remedies); in Amer. Entomol., iii, 1880, p. 181, f. 85 (mention).

GLOVER: MS. Notes Journ.— Dipt., 1874, p. 32, pl. 9, f. 32 (not "33").

HIND: Insects Inj. to Wheat Crops, 1857, p. 104 (description from Fitch).

OSTEN SACKEN: Cat. Dipt. N. Amer., 1878, p. 207 (citation).

LINTNER: in Count. Gent., xliv, 1879, p. 535; in 39th Ann. Rept. N. Y. St. Agricul. Soc. for 1879, (1880), pp. 42–46.

Some stalks of spring wheat, from a field in Scipioville, Cayuga county, N. Y., were submitted to my examination about the 1st of

*Reprinted, with a few changes, from the 39th Report of the State Agricultural Society, of which but 300 copies were issued.

August, which were seriously affected by some insect depredator, thought by the sender to be the "Southern joint-worm."

An examination of the specimens sent revealed the ravages of a quite formidable depredator on the wheat, and one which is broadly distributed throughout the country, although thus far it has attracted very little attention. It does not appear to be known to our agriculturists, and has only, we believe, engaged the study of two of our entomological authors.

Nature of the Attack.

The heads were entirely destitute of kernels. Within some of the husks, the remains of the blossoms were discoverable, showing that their development had been arrested before the formation of the grain. Upon removing the investing sheath, the stem was found to be discolored and shrunken, and quite dry for three or four inches above the joint, and near the joint it was so eaten and shriveled as to be utterly useless for the purpose of conveying the sap.

The Larval and Pupal Forms.

Immediately above the joint, and surrounded by the remains of the stem, larvæ were discovered, a single one in each stem (shown at *a* in Fig. 66), of a watery-green color, elongate, quite tapering toward the terminal end, and subcylindrical at the other, and of a length of about one-fourth of an inch (shown in enlargement at *b*). In some of the stems, larvæ had assumed the pupal stage, not very unlike the larvæ in general appearance, but showing the wing-cases, a more acute form at its head, and more rounded at its anal extremity (represented at *c*).

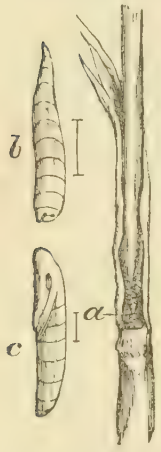

FIG. 66.— The wheat-stem maggot; *a*, the larva, natural size; *b*, larva enlarged; *c*, the pupa enlarged.

The pupæ were also imbedded within the remains of the stem, at about the distance of half an inch from the joint.

Time of Appearance of the Fly.

While examining the stems the day following their reception by me, on August 5th, two of the mature flies were discovered quietly moving over my table. They had probably emerged *en route*, and had escaped unnoticed by me from the box in which the plants had been sent. Although Dr. Fitch mentions the occurrence of this fly in wheat fields during the latter part of June, it appears that the first week in August is within its period of apparition in the State of New York, and, as indicated by the larvæ still unchanged at that time, the flies will continue to emerge throughout the month of August, and perhaps into September.

The Fly Described and Illustrated.

The insect, in its perfect state, is a fly, not unlike our common house-fly (*Musca domestica*) in general shape, but of a more slender form, smaller, and more delicately colored, and more conspicuously marked. It belongs to the family of *Oscinidæ*, which embraces several genera, and quite a large number of American species, of which, by far the larger proportion have been described by Dr. Loew.

This species was first described by Dr. Fitch, in the year 1856, in his *Second Report on the Insects of New York*, as above cited, under the name of *Meromyza Americana*. The description given is as follows: "It is 0.17 inch in length to the tips of its abdomen, and 0.20 inch to the end of the wings. It is yellowish-white, with a black spot on the top of its head, which is continued backward to the pedicel of the neck. Thorax with three broad black stripes, approaching each other anteriorly but not coming in contact, the middle stripe prolonged anteriorly to the pedicel of the neck and posteriorly to the apex of the scutel. Abdomen, with three broad, blackish stripes, which are confluent posteriorly, and interrupted at each of the sutures. Tips of the feet and veins of the hyaline wings blackish. Eyes bright green. Antennæ dusky on their upper side." The fly is shown in Fig. 67.

FIG. 67.—The wheat-stem fly, MEROMYZA AMERICANA; enlarged to six diameters.

Literature of the Species.

No account of the habits or transformations of the insect is given by Dr. Fitch, as they were unknown to him, the flies having merely been taken by him in sweeping with a net over growing wheat. Its transformations were first observed by Prof. Riley, and published by him in the *Rural New Yorker* as above cited.

In his *First Report on the Insects of Missouri*, 1869, its transformations are also described, the larval depredations narrated, and the larval, pupal, and perfect stages figured.

Mr. Townend Glover in his *Manuscript Notes from my Journal—Diptera*, mentions the species and states: "The larvæ live in the stem of wheat, and injure it by gnawing the stalk from within, and by devouring the substance immediately above the upper joint."

It does not appear, from the above brief mention, that it had come under the personal notice of the writer. Baron Osten Sacken has recorded the species in the two editions of his *Catalogue of the Diptera of North America*, as the only known member of the genus, placing it between the well-known genera *Oscinis* and *Chlorops*. The species is

also noticed in Hind's *Insects and Diseases Injurious to the Wheat Crops* [of Canada], Toronto, 1857, but the description is evidently borrowed from Dr. Fitch, and there is no evidence of its having been identified among the Canadian insects. The literature of the species, so far as we can discover, is limited to the above.

Its Occurrence in Missouri in 1867.

Professor Riley noticed its operations about the middle of June, 1867, in all the wheat fields examined by him between St. Louis and seventy miles westward to Bluffton, on the Missouri river. From one to four per cent of the heads of wheat in these fields had turned yellow and apparently prematurely ripened, and on close inspection were found to be stunted and shorter than the rest, and with their kernels withered and shrunken. The last or ear-bearing joint could be easily drawn out of its sheath in a yellow and dried condition, with its lower end irregularly gnawed. The larvæ causing the injury were discovered very near the joint (within one-fourth of an inch). Specimens of the infested stalks were collected, within which the pupal state was soon assumed, and perfect insects emerged during the first week in July, after a pupation of from twelve to fourteen days.

Its Operations not Noticed for Several Years.

From the above notice to the present, we have no positive information of its depredations, but there is every reason to believe that they have been meanwhile continued, while inexcusably attributed to other of the well-known wheat insects, as the joint-worm, Hessian fly and the wheat-midge, by those who should have made themselves acquainted with the very different modes of operation from which their injuries result. It is somewhat singular that investigations were not continued upon an insect of so great economic importance, and that there has not yet been given to us its complete history, commencing with the deposit of the egg.

The occurrence of this insect, in Medina county, Ohio, seems to be indicated by an inquiry made by a correspondent of the *Country Gentleman* (issue of July 27, 1876), from Hinckley, O., for information of the insect which is injuring his spring wheat—a small white worm above the joint nearest the head, causing the head to die before it fills.

Similar Grain-flies in Europe.

In Europe several of the species of *Oscinis* and *Chlorops*, which are closely allied to the Meromyza, are known to be injurious to wheat, rye, and barley, and one of them, the *Oscinis vastator* Curtis, is reported as having the same habit with our *M. Americana*, the larva

living near the base of the stem and eating out the plume of wheat, barley, etc., "thus destroying the future ear." *Oscinis frit* Linn., occupies the husks of the barley, injuring the crop in Sweden annually, as calculated by Linnæus a century ago, to the amount of half a million of dollars. *Oscinis granarius* Curtis, lives in the stems of wheat, but its excessive ravages are restrained by numerous Pteromalus parasites. *Oscinis pumilionis* and *Oscinis glabra* Westw., occur "in the lower part of stems of wheat, rye and barley, causing the plants to become stunted in growth." Other allied species (*O. taniopus* Meig. and others) are said to cause a swelling in the stems of wheat and barley, known in England as the "Gout."

Lack of Knowledge of our Grain-flies.

The great need of the study of our injurious insects is shown in our almost entire ignorance of the habits and transformations of the destructive flies which comprise the family of *Oscinidæ*. Mr. Glover, in his report for the year 1872 (page 134), writes: "It is singular that we hear no particular or decided complaints from our own farmers of any insects in the stalks of wheat, excepting the well-known joint-worm, which is a hymenopterous insect, and has four wings instead of two. We have several species of *Chlorops* in this country, the flies of which are extremely abundant among the plants in grain-fields, and no doubt, do attack our grain in the same manner as the European species, but as yet they have not done sufficient damage to attract the attention of the agriculturist."

Dr. Fitch, in his notice of the wheat and barley flies of the genera *Chlorops* and *Oscinis* and others (*First and Second Report Nox. Ins. N. Y.*, pp. 297, 298, 300), records and comments upon their abundance: "I have the present season discovered these small flies in abundance, in every wheat field in my neighborhood. On sweeping with a net anywhere among growing wheat, a multitude of them will be gathered. They are of several different kinds. * * * * One of these species [*Sapromyza* (*Chlorops*) *vulgaris*] was so abundant the latter part of June, that at almost every step in any of our wheat fields a dozen or more of them could be seen. * * * *

"I doubt not it is from the number of these and other insect depredators which abound upon our wheat, that we are no longer able to produce such crops of this grain as were uniformly harvested formerly, when our lands were newly cleared. How is it possible for wheat to grow with any thriftiness when it is incessantly assailed by such hosts of these enemies, bleeding it at every pore?"

Of the above flies, Dr. Fitch names and describes *Siphonella obesa*, *Chlorops vulgaris*, *C. antennalis*, *Oscinis tibialis*, *O. coxendix*, *O. cras-*

sifemoris, *Hylemyia deceptiva*, *Hylemyia similis* and *Agromyza tritici* (*loc. cit.*, pp. 299–303),— all found upon wheat in wheat-fields, except the latter, which was reared from larvæ crawling in immense numbers from unthrashed wheat in a barn. Of the other eight species, nothing has been published of their depredations, habits or transformations, but we shall probably not err in accepting them as serious pests which are annually levying no inconsiderable tax upon our wheat crops.

One of the undetermined *Chlorops* observed by Dr. Fitch may be presumed to be the *Chlorops proxima*, of Say, the larvæ of which were recently discovered infesting wheat in the month of April, in Fairview, Kentucky, where they were found "working between the blades, and seemingly trying to reach the first joint." The identification was made, and the larva and pupa described, by Professor Comstock (in *Rept. Commis. Dept. Agricul. for the Year* 1879, p. 257), who also gives, in connection therewith (p. 258), the habits of the European species *Chlorops lineata* (so closely related to *C. proxima* as to suggest the specific name of the latter) as given by the Commission of French entomologists which was appointed by the Society of Agriculture to investigate its history and habits, in consideration of the ravages committed by it in the wheat districts.

The Common Name of this and Other Insects.

Now that the *Meromyza Americana* has been discovered in a formidable attack upon the wheat crop in our State, and the method of the injury disclosed, we shall doubtless soon have occasion to make frequent reference to it. For the convenience of ready reference a common name is desirable, which may easily be recalled by those not versed in entomological science; and as the larva is among the largest of the wheat-infesting *Oscinidæ*, it may with propriety be called *the wheat stem maggot*.* The distinctive name may not be agreeable to ears polite, yet it will have the merit of defining the order of insects to which it pertains, and names in popular use should at least convey no erroneous teaching.†

The "army-worm," the "cotton-worm," the "canker-worm," the "joint-worm," the "currant-worm," and the "meal-worm," all belong to a different animal kingdom from the worms; the "grain-weevil" is not a weevil, the latter being a beetle and the former a fly;

*An allied European species, *Chlorops pumilionis*, is known as the wheat-stem fly.

†When these names have been long applied and have come into general use, it might not be advisable, even if practicable, to correct them, but we may be able (and the effort should certainly be made) to prevent a further extension of so objectionable a nomenclature. Some of our entomologists hold to a law of priority in common names as in scientific ones, by authority of which, when once bestowed in a proper publication, they have a valid claim for subsequent use against any others that may be proposed thereafter.

and the "carpet-bug" is a beetle, and not a member of the order of bugs (*Hemiptera*). The name of "maggot" indicates the larval state of a fly, and should be allowed no farther latitude; a grub is understood to be the larva of a beetle, and a caterpillar the larva of a butterfly or moth.

Preventives.

In the event of an increase of the wheat-stem maggot to a serious extent, we regret to have to state, that in all probability, very little can be done to control its ravages, and our main dependence will have to be on parasitic aid. Measures which can advantageously be employed in controlling other of our wheat pests, as turning over the soil or burning the stubble, would be of no avail with this insect. Its pupation and transformation to the perfect stage take place, as previously related, *within the plant*, and it emerges before the grain is harvested. In some of the countries of Europe, where the ravages of the *Oscinidæ* are excessive, whenever they become extremely abundant, relief is found in a resort to the culture of other crops for a few years.

INJURIOUS COLEOPTEROUS INSECTS.

Macrodactylus subspinosus (Fabr.)

The Rose-Beetle.

Ord. COLEOPTERA; Fam. SCARABÆIDÆ.)

Fabr: "Syst. Ent., 1775, p. 39" (*Melolontha subspinosus*).

Lowell: in Massachusetts Agricul. Repos.–Journ., ix, 1826, pp. 143–147.

Harris: in Repts. Commis. Zoölog. Surv. [Mass.], 1838, p. 71; in Mass. Agricul. Repos.–Journ., x, 1827, pp. 1–12; Treat. Ins. N. Eng., 1852, p. 30; in Bost. Cult., xvii, 1855, p. 283; Ins. Inj. Veg., 1862, p. 35, f. 16; Entomolog. Corr., 1869, p. 71.

Emmons: Nat. Hist. N. Y.—Agricul., v, 1854, p. 78, pl. 5, f. 13.

Fitch: in Count. Gent., 1856, p. 75; same, in The Cultivator, 3d ser., iv, pp. 270, 271 (general notice); First–Second Rept. Ins. N. Y., 1856, pp. 245–252, pl. 2, f. 3; in Trans. N. Y. St. Agricul. Soc., for 1856, p. 682 (comparison with *M. barbatus*).

Rathvon: in Rept. Commis. Patents for 1861, (1862), p. 602.

Glover: in Rept. Commis. Agricul. for 1863, pp. 567–8 (habits, food-plants, remedies); Id. for 1867, p. 71 (figure and mention); Id. for 1868, p. 87, f. 65 (brief history), pp. 104, 107–115 (food-plants); Id. for 1872, p. 122 (remedy); Id. for 1874, p. 125 (on grapes).

Walsh: First Ann. Rept. Ins. Ill., 1868, p. 24 (preference for Clinton grape-vine).

Hentz: in Harr. Entomolog. Corr., 1869, p. 69 (rose-bug)

Packard: Guide Study Ins., 1869, p. 454 (transformations).

Wlsh.–Ril.: in Amer. Entomol., i, 1869, p. 251 (on apples).

Bethune: in First Ann. Rept. Ins. Ontario, 1871, p. 78 (history).

Saunders: in Rept. Entomolog. Soc. Ontario, for 1872, (1873), pp. 10, 11, f. 1 (injury to grapes); in Canad. Entomol., xii, 1880, p. 196 (on cherries).

Riley: in Trans. Kans. St. Bd. Agricul. for 1872, (1873), p. 318, f. 18; Fifth Ann. Rept. Ins. Mo., 1873, pp. 108–110, f. 39 (natural history, etc.).

COOK: in Second Ann. Rept. Mich. St. Pomolog. Soc. for 1872, (1873), p. 667 (injury to grapes and history); in Thirteenth Ann. Rept. St. Bd. Agr. Mich. for 1874, (1875), p. 145, f. 41 (remedies).

CROTCH: Check List Coleop. Amer., 1873, p. 59, no. 3445.

LEBARON: Fourth Ann. Rept. Ins. Ill., 1874, p. 87 (mention).

HORN: in Trans. Amer. Entomolog. Soc., v, 1876, p. 184 (sexual differences).

THOMAS: Sixth Rept. Ins. Ill. [1877], p. 103 (habits, remedies, description); Seventh Rept. Ins. Ill., 1878, p. 34 (description).

LINTNER: in Count. Gent., lxv, 1880, p. 407 (description, habits, transformations, etc.).

The appearance of this beetle, in any considerable number, is a sufficient cause of serious alarm to the gardener and fruit-grower. It often makes its advent suddenly, in immense numbers: it is exceedingly voracious, has an extensive range of food-plants, is very difficult to destroy, and is distributed over a large portion of the United States, occurring, according to Dr. Horn, especially in the Northern States, northward of a line from Virginia to Colorado. It has been known for more than a hundred years, during which time it has often forced itself upon public attention by its depredations upon fruits, field-crops, flowers, etc.

Classificatory and Descriptive.

The species, according to our present classification, belongs to the extensive group of Lamellicornes, or lamellicorn beetles, as they are commonly called, from their antennæ terminating in a club consisting of from three to seven thin, flat, movable plates or leaves, as shown in Fig. 68, which can be unfolded and closed like a fan, at the pleasure of the insect. It is a member of the family of *Scarabæidæ*, and of the sub-family of *Melolonthidæ*. The genus *Macrodactylus* signifies long-footed, referring to the long joints of the tarsus as shown below. It comprises only American species, of which but three are known. The common May-beetle, *Lachnosterna fusca*, is an allied species, belonging to the same family. Unlike that beetle, however, the rose-beetle, represented in Figure 68, is comparatively slender and small. Its body is about one-third of an inch long. "It tapers before and behind, and is entirely covered with very short and close ashen-yellow down; the thorax is long and narrow, angularly widened in the middle of each side, which suggested the name *subspinosus*, or somewhat spined; the legs are slender and of a pale red color, and the joints of the feet are tipped with black and are very long."* Dr.

FIG. 68.—The Rose-bug, MACRODACTYLUS SUBSPINOSUS, slightly enlarged; enlarged antenna on the right; enlarged front leg on the left.

*For several interesting features in which the sexes differ, see Dr. Horn's Note in *Trans. Amer. Ent. Soc.*, v, 1876, pp. 183–185.

Harris also describes the larva, as follows: "They attain their full size in the autumn, being then nearly three-quarters of an inch long, and about an eighth of an inch in diameter. They are of a yellowish-white color, with a tinge of blue toward their hind extremity, which is thick, and obtuse or rounded; a few short hairs are scattered on the surface of the body; there are six short legs, namely, a pair to each of the first three rings behind the head, and the latter is covered with a horny shell of a pale rust color." In general appearance this larva closely resembles the "white-grub" of the May-beetle, which is a much larger form, being almost as thick at maturity as the little finger.

Its Food-plants.

The name of "rose-beetle" (perhaps quite as commonly known as the "rose-bug") has been given it, from its appearing at about the time of the flowering of roses, in June, and from the fondness which it displays for roses of all varieties,* with one exception, it is said,—the cinnamon-rose (*Rosa cinnamomea*). When Professor Hentz wrote to Dr. Harris (*loc. cit.*), "our 'rose-bug' is not a rose-bug, for it is never found on that flower as far as I know, which is common here [in Alabama], both in a wild and cultivated state," it would seem that his was a distinct species, or that it had developed different tastes in the Southern States. The rose-beetle is also very fond of other members of the family of *Rosaceæ*, as the apple, plum, and cherry. When abundant, however, it becomes almost omniverous, feeding upon oak and elm and other forest trees; upon wheat and grasses, and on various garden vegetables, as pease, beans, potato, squash, etc. On a single leaf of young corn, only six inches high, twenty-five of the beetles have been counted, and one hundred and five on one hill. Grape-vines suffer severely from their ravages, as they attack at first the blossoms and later the leaves, which they completely destroy, leaving only the net-work; they eat also the young grapes. The Concord vine has been said to be preferred by them to the other varieties, and the suggestion has been made that it might be advantageously cultivated as a lure for them and their more ready destruction.† Entire peach crops have been cut off by them. Young apples, however, seem to attract them in preference to other fruits. They have been observed in apple orchards displaying so great eagerness to eat the fruit, that at

*As showing its fondness for roses, the statement made by Mr. Lowell (*loc. cit.*, p. 145) may be quoted: "Eighty-six of these spoilers were known to infest a single rose-bud, and were crushed with one grasp of the hand."

†Their preference for the Concord vine is not sustained by other observations. Professor Cook, in noticing some deplorable ravages by the insect in some vineyards in Michigan, in the years 1871 and 1872 (*2d Ann. Rept. Mich. St. Pomolog. Soc.* for 1872), states that the Clinton and the Delaware vines were entirely despoiled of their foliage and the crop ruined, while the Concord and the Catawba escaped.

times, where two or three young apples were growing from a single bud, they have mounted upon the back of one another, until a cluster of excited, struggling beetles had accumulated to the size of a man's fist. When they occur in such force, not a single apple escapes, and even the clothing of a person entering the orchard is nearly covered by them. In fields being cut for grass, it is stated that they have arisen in such numbers as to get in the faces and cover the clothing of the mowers. They eat the ox-eye daisy (*Leucanthemum vulgare*) with such a relish that it would be most fortunate if their forces could be concentrated on this noxious weed. They also often occur on the blossoms of the common elder (*Sambucus Canadensis*), and on the sumach (*Rhus typhina* and *R. glabra*).

Its Ravages.

The earliest notice of its ravages in this country appears to have been in Massachusetts, in 1810, where it was reported as entirely destroying a crop of grapes. In 1825, it was so abundant in the same State, that the State Board of Agriculture offered a premium for the best essay on the insect, which should give its natural history and point out efficient means for its destruction. The award was made to Dr. Harris, for his essay, published in the Massachusetts Agricultural Repository, as above cited. So numerous were the beetles at this time, that a large white ox-heart cherry-tree, fifty feet in height, and usually bearing from four to five bushels of cherries, was stripped of every leaf within five days after its first attack, and upon the second day not a cherry could be found on the tree which did not have upon it from two to ten of the beetles.

Mr. Bethune (*loc. cit.*) records an attack made by the beetles upon his garden, at Oakville, Ont.: "They came in vast numbers and devoured every thing — nothing appeared to come amiss to them; they were especially destructive to the grape-vines." In Kansas, in certain years, they are stated to have eaten up the fruit of whole orchards of peaches.

In 1880 the beetle was unusually prevalent in various parts of the State of New York, and particularly in the vicinity of Albany. In Schodack, it attacked the leaves of the fruit trees first, changing to the young fruit as soon as it appeared. Cherries, apples, and pears, were speedily devoured by it. At Loudonville, it was very destructive to the leaves and blossoms of grape-vines, cherry leaves, young apples, rose bushes, various garden vegetables, and the white daisy. "Millions of the beetles hung in clusters from the apple-trees." A correspondent, writing from this place, represents the demonstration as a singularly local one, being almost confined to his own farm, while his neighbor's

grounds on either side were nearly exempt from it. At Adamsville, wherever the attack was concentrated, all the young apples were eaten up, and by beating down the clusters of ravenous beetles surrounding the fruit, into sheets, "bushels were collected and destroyed."

Characteristics of its Appearance.

Many of the invasions of this insect, throughout the United States, have been quite local, and limited to two or three counties of a State. In these instances, the distribution has not been general, but certain towns have alone suffered severely, and in some cases, a single farm, as above stated, has served as a nucleus for the attack.

The sudden appearance of the beetle is an interesting fact in its history. In this latitude it usually appears about the second week in June. Mr. Lowell, in his account above cited, states that on the 1st of June, at eight o'clock in the morning, he gathered a mess of pease, and not a beetle was seen on the vines. Two hours later the vines were literally overrun with beetles of both sexes, most of which were paired. Three hours thereafter, thousands were observed on some rows of beans. These were all killed, and returning to the pease, they were as full as before. Young cherry-trees were attacked and stripped of their leaves in twelve hours. After feeding for about a month, the beetles disappeared almost as suddenly as they came.

Its Natural History.

The sexual instinct is very strongly developed in this species, for whenever several of the beetles are found in company, they occur paired. They mate almost as soon as they emerge from the ground, and the males die a few days thereafter. The female, according to Fitch, when ready to deposit her eggs, enters the ground for the purpose, to a depth of from one to four inches, where she places about thirty eggs. The eggs hatch in about twenty days, and the young larvæ produced from them feed on such tender roots as are accessible to them. They attain maturity in the autumn. Late in autumn, they descend beyond the reach of frosts, where they remain through the winter in a torpid state, and in the spring burrow upward to near the surface, and mould an oval cell by the pressure of their body, within which, in the month of May, they transform to the pupal state. During the early part of June, the thin pupa skin is rent, and the perfect insect digs its way out of the ground.

Remedies and Preventives.

Hand-picking and jarring.— As with most of the beetles whose egg and larva and pupa are concealed beneath the ground, very little, if any thing, can be done to destroy this species in these stages, and it is scarcely vulnerable except in its last and perfect stage. So far as we

know, the insect enjoys an immunity from parasitic attack, and its destruction, therefore, when in excessive numbers, is left to human agency. The most efficient means to control its depredations thus far found, is collecting by hand and killing. When they infest rose-bushes, or other low-growing plants and grape-vines, they can easily be collected in a large tin pan containing some kerosene oil. From fruit-trees, they may be brought down by sudden jars of the trunk or separate branches, upon sheets spread underneath. This may best be done in the cooler parts of the day — in the morning and evening — when they are less active. They can be killed by crushing, burning or scalding with hot water. Under this latter method, they may be utilized to a certain extent by feeding to poultry. The injuries which have been reported to poultry fed upon them is doubtless owing to their having been eaten in their living state, and the irritation consequent on the active movements of their strongly spined legs.

The beetles should be gathered daily during the continuance of their abundance. Dr. Lowell, previously cited, collected them every morning for about a week, and from a quarter of an acre destroyed, on a moderate estimate, a hundred thousand.

Plaster and Tansy applications.— Plaster thrown upon grape-vines when wet with dew is said to make the leaves unpalatable to them and drive them away. A correspondent of the *Country Gentleman* states that he has had good results from syringing his vines with water in which tansy has been boiled. The application of soap-suds and tobacco-water has not proved of service.

Protection by netting.— Where it is desirable to preserve a few vines or plants from attack, it has been accomplished, in some instances, by inclosing them in millinet or some close netting. The above, however, are simply palliatives, and there is scarcely a doubt but that the proper method to combat this, at times one of the greatest scourges of our gardens and nurseries, is to collect and destroy them.

Euphoria Inda (Linn.).

The Indian Cetonia.

(Ord. COLEOPTERA : Fam. SCARABÆIDÆ.)

Scarabæus Indus LINN : Syst. Nat., Ed. x, i, 1758, p. 352 ; Mus. Ulricæ, 1764, p. 27; Syst. Nat., Ed. xii, ii, 1767, p. 556, no. 71.

Trichius Inda FABR : Syst. Ent., 1775, p. 40, no. 2 ; Sp. Ins., 1781, i, p. 48, no. 2 ; Mant. Ins., 1787, i, p. 25, no. 3 ; Syst. Eleuth., 1801, ii, p. 132, no. 6.

Cetonia Inda OLIVIER : in Encyc. Method.— Hist. Nat.— Ins., v, 1789, p. 421, pl. 160, f. 13.

Cetonia barbata SAY : in Journ. Acad. Nat. Sci. Phila., iii, 1824, p. 239.

Cetonia Marylandica FRÖHLICH. *Cetonia brunnea* DEJEAN.

Cetonia Inda HARRIS : Rept. Ins. Mass., 1841, p. 36 ; Treat. Ins. N. Eng., 1852, p. 35 ; Ins. Inj. Veg., 1862, p. 40, f. 17 (description and habits).

Erirhipis Inda BURMEISTER: Handb. Entomol., iii, 1842, p. 389.
Cetonia Inda. EMMONS: Nat. Hist. N. Y.— Agricul., v, 1854, p. 79, pl. 12, f. 6.
Euryomia (Erirhipis) Inda. GLOVER: in Rept. Commis. Agricul. for 1868, p. 90, f. 84 (habits, etc.).
Euryomia Inda. PACKARD: Guide Study Ins., 1869, p. 457 (mention).
Euphoria Inda GEMMINGER et HAROLD: Catalog. Coleop., 1869.
Euryomia Inda. CROTCH: Ch. List Coleop. Amer., 1873, p. 62, no. 3646.
Euryomia Inda. LEBARON: Fourth Ann. Rept. Ins. Ill., 1874, p. 91 (mention).
Euryomia Inda. THOMAS: Sixth Ann. Rept. Ins. Ill. [1877], p. 108 (description, habits, etc.).
Euryomia Inda. LINTNER: in Count. Gent., xlii, 1877, p. 585(*Cetonia*); in 38th Ann Rept. N. Y. St. Agricul. Soc. for 1878, pp. 67–69; Separate, as Rept. Inj. Ins. for 1878, (1880), pp. 10–12 (habits, description, etc.).
Euryomia Inda. RILEY: in Ann. Rept. Commis. Agricul. for 1878, (1879), p. 208, (attacking corn); Separate, as Rept. of Entomologist for 1878, p. 4.
Euphoria Inda. AUSTIN: Supp. Ch. List Coleop. Amer., 1880, p. 26 (generic change).
Euryomia Inda. SAUNDERS: in Canad. Entomol., xiii, 1881, p. 1, f. 1; in Ann. Rept. Ent. Soc. Ontario for 1881, p. 19, f. 3 (brief notice).

For many of the years of the early growth of entomological science in our country, this species was known under the name by which it was first brought to popular notice in the successive editions of Dr. Harris' valuable Report on the Insects of Massachusetts, viz., *Cetonia Inda*, and the common name applied to it at the time — the "Indian Cetonia." Although no longer retained in the genus *Cetonia*,— having since held place in several genera,— and as it may still be subjected to farther change — there seems to be no good reason why the first popular name applied to it should not be continued.

Alarm Excited by "a New Corn-bug."

From various sections of the State of New York and from New England, complaints were made, during the autumn of 1878, of an insect which was proving very injurious to standing corn, by burrowing beneath the husks and feeding upon the kernels. All the accounts concurred in the statement that it had never before been known to prey upon corn. The following notice of it is extracted from a New Haven, Conn., paper of September 7th, 1878 :—

"*The Corn-bug.*—The corn-fields of the interior of the State are suffering from a brown-colored, six-legged bug, having a broad body and a small head, which starts at the tips of the ears and works through to the butt, devouring the kernels. Meriden and Burlington report the ravages of the pest. A correspondent from the latter place says: 'Fields of corn are ruined almost in a single day.' A gentleman, of Woodbridge, picked twenty of the bugs off two ears of corn, August 30th. The general impression among farmers is, that this pest will prove more disastrous than the potato-bug."

From examples received by me, it proved to be no new insect, but

one that had long been known to science, and familiar to all entomologists under the old name of *Cetonia Inda*.

Habits of Associated Species.

The Cetonians, as the associated species have been called, belong to the Lamellicornes, in company with the Rose-bug and May-beetle. They are pre-eminently flower-beetles, their mouth-organs being provided with a brush of hairs with which to collect the pollen of the flowers that they frequent, as those of the golden-rod (*Solidago*), *et cet.* They are diurnal in their habits, flying actively about, with a loud humming noise like that of bees, in the warm and bright sunshine.

They appear abroad very early in the year, and I have captured examples sporting in sunny places in the woods while large bodies of snow were to be found elsewhere. Professor Forbes, of Normal, Ill., has found the species in the stomach of blue-birds (*Sialia sialis* L.), shot at Normal, in the month of March.

The Cetonians were formerly arranged in the family of *Cetoniadæ*, but later they have been placed by Dr. LeConte in the family of *Scarabæidæ*, and in the subfamily *Pleurosticti* (from the position of the abdominal spiracles), in which they constitute the tribe *Cetoniini*.

Description of the Indian Cetonia.

Thirty-one species of this tribe are known to North America, of which the *C. Inda*, or as it has been designated since the latest authoritative subdivision of the old genus of *Cetonia* — *Euphoria Inda*, is our most common species. It is a thick-bodied insect, measuring about six-tenths of an inch in length, by nearly four-tenths broad. Its appearance is shown in Fig. 69. Harris describes it as having "a broad body, very obtuse behind, with a triangular thorax, and a little wedge-shaped piece on each side between the hinder angles of the thorax and shoulders of the wing-covers; the latter, taken together, form an oblong square, but are somewhat notched or widely scalloped on the middle of the outer edges. The head and thorax are dark copper-brown or almost black, and thickly covered with short, greenish-yellow hairs; the wing-cases are light yellowish-brown, but changeable with pearly and metallic tints, and spattered with numerous, irregular, black spots; the underside of the body, which is very hairy, is of a black color, with the edges of the wings and the legs dull red."

FIG. 69.—The Indian Cetonia, EUPHORIA INDA, natural size; *a*, *b*, *c*, enlargements of antenna, anterior leg, and posterior leg.

American Entomologist, iii, 1880, p. 216.

Surprise at its Appearance as a Corn Depredator.

That one of our flower-beetles should present itself to our notice as a corn-pest has excited no little surprise among entomologists. Its habit of frequenting sap-trees in the spring to partake of the sap has long been known, and it is charged with the crime of occasionally burrowing into ripe peaches to feed upon the sweet and luscious pulp.* An entomological correspondent of the New Haven paper from which we have quoted above, Mr. H. F. Bassett, questions the statements made that this insect is the author of the injuries credited to it, and says: "It would be just like it to prowl around and in ears of corn that some bird or beast had meddled with, but to strip the husks off and gnaw the cobs would be quite beyond the power of any flower-eating beetle known to me, their mouth not being fitted for hard or difficult work."

Earlier Notices of its Injuries to Corn.

The above-mentioned writer also states that he had looked over a large portion of our economic entomological literature, consisting of the New York reports of Dr. Fitch and the Missouri reports of Riley, the reports of the Canadian Entomological Society, and the volumes of the American Entomologist, without finding any reference to this species as particularly destructive to any thing but sweet, juicy fruits. Upon further search of our writers, I find that he had overlooked a statement made by Dr. LeBaron, formerly State Entomologist of Illinois, in his Fourth Annual Report (1874), where in a brief reference to *E. Inda*, he has written of it: "It is sometimes troublesome by burrowing into ripe fruit, and also by feeding upon sweet corn in the milk." Dr. Harris states that about the middle of September, it may be found in great numbers on corn-stalks, feeding upon the sweet sap; and Mr. Glover has seen it in the South, feeding on the exuding sap of cotton-bolls.

Its Attack Probably Follows Previous Injury.

The idea advanced by Mr. Bassett, above quoted, that this insect is not alone answerable for the injury to the corn, finds support in a communication to the *Country Gentleman* of January 16, 1879, from a correspondent at Flushing, New York, which at the same time adds another count to the formidable bill of indictment against that notorious avian pest — the English sparrow! The correspondent writes: "I had fifty or sixty hills of corn planted in my garden, which came up and thrived wonderfully, and we found it deliciously sweet; so did the English sparrows. For a considerable time we found, after it was

*Dr. Harris states that he has taken a dozen of them from a single peach, into which they had burrowed so that nothing but the naked tip of their hind-body could be seen; and not a ripe peach remained unbitten by them on the tree.

fully ripe, many ears were eaten for five or six inches from the top, and upon examining the places closely, I found one or two bugs in each one about the size of the Colorado-bug, with a mottled back something like in color to a tortoise shell, with considerable hair on the underside and legs, which I picked off and destroyed. This I followed up for three or four days, but one morning, going to the corn earlier than usual, I saw on one ear seven of the sparrows making a new opening where there was none before. Of course, here was the solution. After I had put a coat, pantaloons and hat on some sticks nailed together and stood it up in the middle of the corn, I had no more trouble with them. I supposed that the bugs did the mischief, but they had only entered where the birds had made an opening."

It is quite probable that the season (summer of 1878) was one in which the species occurred in unusual abundance, and its ordinary food not being met with in sufficient quantity to supply the wants of such a host, it was led to resort to the juices of the tender corn, as an exceptional article of food.* The excitement created by the advent of the new corn insect in several localities from which examples were received, was allayed by the assurance which we were able to give, that its large numbers at this time would not probably be followed by an increased or even an equal number the next year, it being well known to entomologists, that a year noted for the abundance of some particular species of insect may be followed by many when the same insect will be rarely met with.

Time of its Appearance.

Dr. Harris' statement that this insect has its second brood about the middle of September, in Massachusetts, may need some modification. Examples of this brood were found as early as the middle of August, near Bridgeport, Conn. Mr. Bassett records its having been seen by him feeding on the sap which flows from certain woody galls on oak trees. The intense bitterness or acidity of most galls would seem to be very unlike the sweets for which it manifests so great partiality.

Mr. Bland, in a communication to the Entomological Society of Philadelphia (*Proc. E. S. Ph.*, i, 1864, p. 42), reports finding the species on the 25th of August, in Camden county, N. J., abundant on *Vernonia Noveboracensis.*

Another species of this genus, the *Euphoria melancholica* Gory, of which a figure is given in the *American Entomologist*, vol. ii, p. 61,

*Its abundance at this time is recorded by the Entomologist of the Department of Agriculture, in his résumé of the correspondence of the Department for the year 1878, as follows: "One of the commonest flower-beetles (*Euryomia inda*) has been received from several correspondents as attacking green corn — a habit which the species was not before known to possess, and which has, beyond much doubt, been recently acquired."

fig. 39, is frequently found in Illinois, boring into apples, and is represented as fond of eating into the flowers and fruits of a variety of plants.

Other Injuries by the Insect.

Professor H. Osborn, of the State Agricultural College of Iowa, in his Entomological Report for 1879, made to the State Horticultural Society (pp. 85–107), records a habit reported to him as recently observed in this beetle, which has not been previously recorded, and which will require verification before it can be accepted. The beetle had been sent to him, with the statement that it had done much damage to apple-trees by gnawing off the bark, and that one tree had been entirely ruined. The portion of the branch which accompanied the beetle was so badly damaged as to resemble the girdling done by rabbits and mice.

As we cannot accept the tearing open of the husks of the corn to reach the tender kernels, by this flower-beetle, for like reasons it seems far more probable, that the above injuries to the apple-trees had been committed by some other depredator, and that the beetle found upon the wounds had merely been drawn thither to feed upon the oozing sap.

From the known habits of allied Cetonians, this species is, in all probability, injurious in its grub or larval state to the roots of many of our cultivated plants, but as its history has not as yet been worked out, we remain ignorant of the nature and extent of its injuries. A species nearly related to it, *Allorhina nitida* Linn., has been noticed at times as quite injurious to strawberries,* after the habit of the green rose-chafer, *Cetonia aurata*, of Europe,† and there is little doubt but that *E. Inda* will be hereafter found attacking the same plant. Although Curtis distinctly states that *C. aurata*, in its grub state, lives two or three years under ground, feeding on the roots of grass and various plants and breeding amongst strawberry beds, yet it is questioned by some of our writers whether injuries of serious amount are committed by these insects in their larval stage. The belief seems to be gaining ground that their food consists mainly of decaying vegetable matter. Dr. Thomas is of the opinion that *E. Inda* breeds in decayed wood, as the beetles may often be seen flying over chip-yards as if in search of a place to deposit their eggs.‡

A Grass-feeding Larva of an Allied Species.

In corroboration of their grass-feeding habits, we have the interesting account given us by Mr. L. O. Howard,§ of the remarkable occur-

**American Entomologist*, i, 1869, p. 246.
†Curtis' *Farm Insects*, 1861, p. 107.
‡*Fourth Ann. Rept. Ins. Ill.*, 1874, p. 91.
§*Canadian Entomologist*, xi, 1879, p. 200.

rence of thousands of the larvæ of the May-beetle, *Lachnosterna fusca* Fröhl., observed by him, on one occasion, on the stone pavements adjacent to the Capitol Building at Washington; and of the statement made to him by the Superintendent of the grounds, that the sweepers of the walks would frequently collect as many as a bushel basket full of the larvæ. Professor Riley has informed me that it has been subsequently ascertained that the above species was not the May-bug, but the *Allorhina nitida** ; and, he suggests, that while their larvæ must have been feeding upon the roots of the grass within the grounds where they were found in such excessive numbers, still, as there are always many decaying rootlets among all grasses, it is possible that their food may, in part, have consisted of these.

The *E. Inda* is of serious harm at times in its resort to flowers to feed upon the pollen, by its destroying the anthers and thus rendering the blossom abortive.

Preventives and Remedies

Guarding corn from attack by birds.— It is but seldom that this species occurs so abundantly as to become a serious corn-pest. In seasons of unusual abundance, its depredations upon corn could undoubtedly be prevented by guarding against the opening of the corn-husks to admit of their entrance. As the first attack upon the corn appears, in most cases, to be made by small birds, if these can be kept away, the resultant attack of the beetles will be prevented. When they have discovered the exposed kernels of corn, and commenced to feed upon them, it will then be necessary to collect the beetles by hand and destroy them.

Catching the beetles in nets.— When they are attracted to ripe fruits, they may easily be discovered in their circling flight around the trees, by the loud humming which they produce, when they may be captured in nets attached to long handles.

Hand-picking from flowers.— When they frequent flowers and blossoms to feed upon the pollen, they should always be picked off and killed.

Collecting the larvæ after heavy rains.— If there is reason to believe that the larvæ are depredating upon the roots of grasses, search should be made for them on the surface of the ground after heavy rains, when, in the proper season, large numbers may perhaps be collected. This method of prevention is educed from Mr. Howard's observations (*loc. cit.*), from which it appears to be the habit of *A. nitida* (and by inference, of *E. Inda*, also) to appear above ground at such times, when

*Mr. Howard also makes the correction in the *Canadian Entomologist*, xiv, 1882, p. 240, and states that the error was shown by rearing the larvæ to the perfect state.

near maturity. The date of the remarkable appearance of *A. nitida* at Washington, was September 14th. About the middle of September, or somewhat later for more northerly latitudes, would therefore be a proper time for searching for these larvæ. The experiment might also be made, when their presence is suspected in grass-plots, of sprinkling the ground copiously with water, in the hope that they will present themselves above ground in response to the invitation.

Crioceris asparagi (Linn.

The Asparagus Beetle.

(Ord. COLEOPTERA: Fam. CHRYSOMELIDÆ.)

LINNÆUS: Faun. Suec., 1796, Ed. i, p. 151; Ed. ii, p. 172; Syst. Ent., p. 601, no. 112

WESTWOOD: Introduc. Mod. Class. Ins., i, 1839, p. 374, f. 45, nos. 15–18 (figs. of eggs, larva and imago).

KOLLAR: Ins. Inj. Garden, etc., 1840, p. 140 (general description of larva and imago).

CURTIS: Farm Insects, 1860, p. 307 (mention).

FITCH: in Count. Gent., xx, 1862, pp. 81, 82 (discovery, transformations, etc.); in Trans. N. Y. St. Agricul. Soc., xxii, 1863, pp. 659–668 (introduction, distribution, life history, etc.); Sixth–Ninth Repts. Ins. N. Y., 1865, pp. 177–185 (same, and figures from Westwood).

GLOVER; in Rept. Commis. Agricul. for 1865, p. 91 (importation).

WLSH.–RIL.: in Amer. Entomol., i, 1868, pp. 114, 115, f. 94 (history, and figures from Westwood).

PACKARD: Guide Study Ins., 1869, p. 502 (notice of introduction); in Ninth Rept. G.–G. Surv. Terr., 1877, p. 764 (brief notice).

DODGE: in Rept. Commis. Agricul. for 1870, p. 513 (damages).

——, in Count. Gent., xxxvii, 1872, p. 520, c. 3; Id., xlvi, 1881, p. 391, c. 1 (remedies).

CROTCH: Check List Coleop. Amer., 1873, p. 94, no. 5558.

THOMAS: Fourth Rept. Ins. Ill., 1874, p. 165 (mention); Sixth Rept. do., [1877], p. 158 (description and remedy).

FULLER: in Count. Gent., xli, 1876, p. 683; Id., xliv, 1879, pp. 743, 791; in Amer. Entomol., iii, 1880, pp. 3-5 (lime remedy).

ORMEROD; Rept. Inj. Ins. for 1877, (1878), p. 17 (remedy); Manual of Inj. Ins., [1881], pp. 1–3 (description, remedies and figures).

COMSTOCK: in Rept. Commis. Agricul. for 1879, (1880), p. 216–218, pl. 3, f. 4 (notes and original figures).

LINTNER: in Count. Gent., xlvi, 1881, p. 243 (history, description, habits and remedies).

This beetle seems steadily to be extending its depredations to new localities, as complaints are being made from time to time, of its first appearance in different places, and information is solicited of its habits and the means of destroying it. It is fortunate, in view of its destructiveness, that its progress, unlike that of another member of its family — the Colorado potato-beetle — is quite slow, and that it as yet gives no manifestation of its distribution throughout the United States.

During the early years of its operations in this country, it was estimated that its rate of distribution would be about twenty miles a year. This rate of progress, however, has not been sustained. About twenty-five years have passed since its introduction, and during that time, it has not extended to any great distance from the sea-coast, where most of our larger asparagus plantations occur. As yet, we only hear of its serious injuries from Long Island, the vicinity of New York city, New Jersey, Eastern Pennsylvania and Southern Connecticut. It doubtless exists beyond these limits, but I find no published statements of its presence elsewhere. We have not yet observed it in the vicinity of Albany.

Its Introduction into the United States.

The asparagus beetle is one of the many injurious insects which have been brought to this country from Europe, and it is among the latest imported. It is not known how long it had existed in Europe, or where it originated, but there is reason to believe that for several centuries it had no general distribution. Asparagus had been cultivated in Europe from a very early date — at least 60 years before the Christian Era. It was held in much favor by the Greeks, and the Romans must have acquired great skill in its production, for according to Pliny, three shoots of that grown at Ravenna weighed a pound. Linnæus states (*loc. cit.*), that the gardeners believe that the beetle was imported from Russia, but that it was never known as obnoxious there. Fr. Th. Keppen, in his *Obnoxious Insects of Russia*, p. 273, 1880, states that *Crioceris asparagi* is sometimes common in Russia and the Caucasus, but never proves obnoxious.

In this country it was first noticed at Astoria, near the western end of Long Island, in the year 1859, the same year in which the first specimen of the imported cabbage-butterfly (*Pieris rapæ*) was captured by Mr. Couper, within the city limits of Quebec. The actual importation of the two species was probably three or four years earlier, in 1856 or 1857. Mr. Ulke is reported to have taken some specimens of the beetle in or near the city of New York as early as the year 1858 or 1859.

Its Spread Throughout Long Island.

In 1860 it proved moderately destructive at Astoria, increasing its injuries the following year, and the third year, destroying the grown plants to the extent of killing the roots and necessitating the plowing up of the beds.

In 1862, it had spread as a serious pest over all the asparagus plantations of Queens county, Long Island. The attention of Dr. Fitch was called to the invasion. He visited the locality for the purpose of

investigating the habits of the insect, and from the careful observations made, gave a very interesting paper upon it, embracing also the history and culture of the asparagus plant, in his *Eighth Annual Report on the Insects of New York*, published in the *Transactions of the State Agricultural Society*, vol. xxii, 1863. A previous publication, describing the insect in its different stages, had been made by Dr. Fitch, at a somewhat earlier date, in the *Country Gentleman*, as above cited. In this year it had already spread along the north shore of Long Island for a distance of forty miles. It threatened to ruin every plantation in Queens county, at a prospective loss estimated at $50,000 annually.

A Parasitic Attack.

In the year 1863, when to all appearance the cultivation of asparagus was arrested, relief came through the attack of "a small, shining-black parasitic fly," belonging to the family of *Chalcididæ* or *Proctotrupidæ*, which is supposed to have laid its eggs in the eggs of the asparagus beetle or in the larva, and by the destruction of large numbers of them, materially to have checked the depredations of the insect (*American Entomologist*, i, 115). I do not find any particular account of this valuable parasite, which seems, very strangely, not to have received scientific attention.

Its Extension into New Jersey.

For some following years, less was heard of these injuries on Long Island, which may in great part have resulted from an experience gained in methods for their prevention.* In the year 1868 it was noticed in New Jersey, where it has since proved very destructive. In the second year of its operations at Burlington, N. J., one-fourth of the asparagus crop was destroyed; in several instances, entire beds were ruined in the third year of the attack. It has also been very destructive in Essex county, in the same State. The present year complaints have reached me, from Camden, N. J., of the great difficulty encountered in efforts to check the increase (*Country Gentleman*, for April 14, 1881).

FIG. 70.—The Asparagus beetle, CRIOCERIS ASPARAGI, its eggs and larva in natural size; also, the eggs and larva enlarged to about three diameters. (After Fitch.)

Its Description.

The egg.— The eggs of the beetle are of the size and form shown at the middle of Fig. 70. At the right, they are given in enlargement.

*In 1878, it was reported as very serious in Suffolk county, in the vicinity of Quogue, near the eastern end of Long Island (*Report of the Entomologist of the Department of Agriculture* for the year 1878, p. 3).

Their color is blackish-brown. They are placed on end on the young plant, usually in rows of from two to seven. When the plants are grown, the eggs are deposited on the leaves near the end of the delicate branches.

The larva.— The young larva and the mature form are represented upon the upper portion of the stem, and on the left in the figure, it is given enlarged. Its greatest length is about one-fourth of an inch. "It is of an obscure olive or dull ash-gray color, often with a blackish stripe along the middle of the back. It is soft and of a flesh-like consistency, about three times as long as thick, thickest back of the middle, with the body much wrinkled transversely. The head is black and shining, and the neck, which is thicker than the head, has two shining black spots above. Three pairs of legs are placed anteriorly upon the breast, and are of the same shining black color with the head. As will be seen when it is crawling, the larva clings also with the tip end of the body; and all along its under side may then be seen two rows of small tubercles, slightly projecting from the surface, which serve as prolegs in addition to the tip of its body. Above these tubercles on each side is a row of elevated shining dots like warts, above which the breathing pores appear like a row of minute black dots." (Fitch.)

The beetle.— The beetle is a very pretty insect in its trim form, contrasting colors of yellow, red and shining-black, and its conspicuous ornamentation. Its average length is a little less than one-fourth of an inch. The head is black, with the first three joints of the short antennæ smaller and differently colored from the remainder. The finely punctured thorax is tawny-red, marked more or less distinctly on its crown with two black spots. The wing-covers are punctured in rows, and usually appear of a lemon color, broken into three spots on each, as in the accompanying figure, by a black stripe along their junction, a black transverse band a little behind their middle, and an interrupted one near their tips. Outwardly the wing covers are bordered with orange. The body beneath and the legs are shining black, the latter sometimes showing a yellowish band upon them. Examples having the wing-covers marked as above, suggest the representation of a black cross upon the back, for which reason it is sometimes known in England as the "cross-bearer."

FIG. 71.— The Asparagus beetle (the "cross-bearer" form), its larva, and its eggs upon a young plant.

In some of the beetles, the wing-covers may be described as blue-black, with an orange margin on the sides and at the tip, and above with six small yellow spots. Fig. 72 from examples in my collection, received from a market in New York city, is the variety which Dr. Fitch seems to have had before him for his careful description. "Along the middle of each wing-cover is a row of three lemon-yellow spots. The anterior one of these is placed upon the base of the wing cover, and is usually egg-shaped with its pointed end directed backward. The middle spot is placed at a third of the distance from the base to the tip of the wing-cover. It is transverse, being a third more broad than long, and is thicker toward its inner end, which terminates at the third row of punctures from the suture, its opposite or outer end being confluent with the orange border. The hind spot is placed nearer to the middle spot than to the widened orange tip of the wing-cover. It is similar in most respects to the middle spot, but is frequently smaller and placed somewhat obliquely, its inner end inclining backward, and its outer end uniting with the orange border by a narrow neck."

FIG. 72.—Asparagus beetle (a common six-spotted form), enlarged about six diameters, with further enlargement of antenna and front tarsus.

The above variety would hardly be recognized as identical with the form usually figured. The elytral spots have been described in general terms as very variable in shape and size. Fitch notes their great variation. It is interesting to find that such marked variation in individuals can co-exist with such permanency of feature, that the pattern so minutely described by Dr. Fitch is exactly that shown by the example figured from my collection.

Its Family Relations.

The family of *Chrysomelidæ*, to which the asparagus beetle belongs, is a very extensive one, and is estimated by Dr. Packard to contain from 8,000 to 10,000 species.* The Crotch Check List records the names of nearly 500 North American species. In appearance, these insects are of rather small size, oval or oblong in form, often quite convex above, with prominent eyes, short antennæ, a narrow cylindrical thorax generally, and often with the hind thighs much thickened. The family was formerly more restricted than at present — Westwood and others recognizing distinct families of *Criocerida*, *Cassidida* and *Galerucida*, which more recently, together with other groups, which

Guide to the Study of Insects, 1869, p. 501.

had been regarded as of family value, have been united by Dr. Le Conte, Dr. Horn, and others, as the *Chrysomelidæ*, with ten subfamilies, of which the Criocerides form one. Many of the members of this family as now constituted, are very destructive to our crops and especially to the products of the garden, in both their larval and perfect stages, by feeding on the leaves: the larvæ of some destroy plants by boring into the roots. We may cite as familiarly known representatives, the three-lined leaf-beetle, *Lema trilineata* (Oliv.); the striped cucumber beetle, *Diabrotica vittata* (Fabr.); the cucumber flea-beetle, *Epitrix cucumeris* (Harris): the grape-vine flea-beetle, *Graptodera chalybea* (Ill.); the turnip flea-beetle, *Phyllotreta striolata* (Fabr.); and the Colorado potato-beetle, *Doryphora 10-lineata* (Say).

Recent Introduction of another Asparagus Beetle.

The *C. asparagi* has for a long time remained the only representative of the genus *Crioceris*, in the United States. Recently, however, a second species has been introduced, which, it is feared, may prove more injurious to asparagus than its naturalized congenor. We quote from the *American Naturalist*, for February, 1883:—

"Mr. Otto Lugger, of Baltimore, Md., has already recorded the recent introduction from Europe of a second asparagus beetle, the *Crioceris 12-punctata* Linn., which in Europe occurs commonly wherever asparagus is cultivated, without, however, doing serious injury. Mr. Luggar found it first in the summer of 1881, near Baltimore, in small numbers and quite local, but it has recently proved even more troublesome than *C. asparagi*. From the latter species this new enemy may at once be distinguished by its less elongate form, and by the bright orange-red of the upper surface, each elytron being marked with six small black dots."

Miss Ormerod remarks of this species that it is seldom found in England.

Natural History.

The history of *C. asparagi* is, in brief, as follows: The beetles destined to continue the species, survive the winter in dry, sheltered places, as beneath bark, in crevices of wood, and under the clapboards of buildings. Simultaneously with the appearance of the asparagus shoots in early spring, they emerge from their winter quarters, and commence to feed upon the tips of the plants. The sexes pair, and the female deposits her eggs upon any portion of the exposed shoots. The eggs hatch in an average period of eight days. The larvæ eat voraciously and grow rapidly, so that they complete their growth in about twelve days. They then leave the plants and enter the earth for a short dis-

tance or merely conceal themselves beneath dead leaves or other material on the surface. Constructing a slight cocoon, they undergo their transformation, and remain in their pupal state for about ten days. Thirty days complete the cycle from the egg to the perfect insect. Almost as soon as the beetles emerge, they pair, as the sexual instinct is strongly developed in them, as is shown in the frequency in which they come under our observation mated. The eggs are then deposited, and the beetles continue to feed upon the plants, eating holes into the bark of the more tender branches for several days: one was found by Dr. Fitch to feed for a fortnight in confinement. A second brood results from these, appearing about the first of July, followed by a third, probably in August. Hence we have the larvæ and the beetles with us, in their successive broods, through the spring and summer, into September.

Remedies and Preventives.

Hand-picking and beating.— Although this beetle has been known for nearly a century in Europe as a serious asparagus pest, yet no other remedies for its injuries, until very recently, have been suggested, so far as we know, except that given by Kollar, who states that "the only means of destroying these insects is picking off and killing the beetles and larvæ," and by later writers, to shake them off into a pan of water, when they may be crushed under foot, or killed by pouring boiling water upon them. These methods would obviously be ineffectual for the destruction of the hosts that concentrate in our large plantations of this highly prized esculent on the sea-board, sometimes twenty acres in extent, or in the even larger plantations now cultivated in England.*

Fowls for hunting them.— The only recommendation that Dr. Fitch, at the time of his writing, was able to make, was to turn in a flock of fowls and permit them to range over the plantation. They pursue with avidity the beetles, which are evidently attractive morsels to them, and they do not molest the plants — the asparagus being an exception to their fondness for many of the garden vegetables.

Lime dusting.— Mr. A. S. Fuller, of Ridgewood, N. J., has furnished to the *American Entomologist*, for January, 1880, a method for destroying this pest, which, as it presents the result of his personal experience, seems to be all that is needed for the purpose. Shortly after its appearance on Long Island, it was discovered, according to Mr. Fuller, that freshly-slacked lime, scattered over the plants, would instantly kill

*The largest cultivator in Deptford has eighty acres entirely laid out in asparagus beds. — *Lib. Entertain. Knowl., Veg. Subst.*, p. 276.

every larva that it touched. The lime may be conveniently applied by using an old broom for a duster, or a Paris green sifter. With a pail full of dry lime, a man could in a short time dust an acre of asparagus. "The lime is best applied in the morning while the dew is on, for then a portion will adhere to the plants as well as the grubs, and during the day or days following it will be constantly dropping down or blowing about among the leaves and branches, thereby making the escape of any of the larvæ all the more uncertain. * * * * * * For the past sixteen years, I have used lime as described, upon my asparagus beds, to keep the insect in question in check, *and it has done it so effectually that about one application every alternate season has been sufficient*" (Fuller). Not only is lime cheap and readily procurable everywhere, but it is also of benefit to the asparagus roots. It has also the additional merit as an insecticide, that it can be used upon the young plants while they are being cut for market, for the destruction of the first brood of larvæ, while Paris green or London purple may not safely be used.

Cutting away the young seedlings.— The Long Island gardeners have found great relief from the excessive ravages of this insect by cutting down in the spring at the time when the beetle is ready to deposit its eggs, all the young seedlings which are usually selected for oviposition as well as for food, and thus forcing the beetles to deposit their eggs upon the new shoots. These being cut for market almost daily do not permit the eggs to hatch, and by this means, the greater portion of what would be the second brood is destroyed.

Removing the seed-stems.— It has also been recommended to cut down all the seed-stems as soon as the asparagus season is over, and to repeat the process once or twice during the season, leaving the beds bare and smooth. It is difficult to see how this entire destruction of the leaves of the plant can fail of proving injurious to it, the action of leaves being deemed essential to the proper development; yet Mr. H. H. Sargent, in a communication to the *Gardeners' Monthly*, states that the earliest, best, and largest asparagus in his neighborhood was grown by this method of treatment, which had been continued for five successive years (*Country Gentleman*, Aug. 15, 1872).

As, however, the asparagus plant occurs in a wild state along the roadsides and in fields and woods upon Long Island, and presumably in New Jersey and other localities where it has been for some time cultivated, the above method could only serve to alleviate the evil, for a sufficient supply of food would thus be furnished the insect for its propagation and subsequent colonization upon cultivated tracts.

Phytonomus punctatus (Fabr.).

The Punctured Clover-leaf Weevil.

(Ord. COLEOPTERA: Fam. CURCULIONIDÆ.)

FABR.: "Syst. Ent., 1755, p. 150, no. 119; Sp. Ins., 1781, i, p. 190, no. 166; Mant. Ins., 1787, i, p. 117, no. 221."

OLIVIER: in Enc. Method., v, 1790, p. 541, no. 315 (descript. as *Curculio punctatus*).

RILEY: in Amer. Nat., xv., 1881, p. 751 (discovery); Id., p. 913 (congeners, habits, eggs and larva); Id., xvi, 1882, p. 248 (*P. opimus* is same); in Ann. Rept. Dept. Agricul. for 1881, pp. 171–179, pl. 10, f. 1 (life-history, early stages, remedies, etc.).

LINTNER: in Elmira Husbandman for Sept. 14, 1881; in Count. Gent., xlvi, 1881, p. 647 (introduction, description, etc.).

LE CONTE: in Proc. Amer. Phil. Soc., xv, 1876, p. 124 (*Ph. opimus*); in Monthly Proceed. Ent. Sect. Acad. N. S. Phila., Oct. 1881, p. xxxvi (identical with *P. opimus*, Lec.).

This species is a late addition to our list of insect pests. It is an European species first described by Goeffrey in 1762, but without specific name; in 1775 it was again described by Fabricius as *Curculio punctatus*. The first public notice of its occurrence in this country was given by Professor Riley, in a verbal communication made at the meeting of the American Association for the Advancement of Science, held at Cincinnati, in August, 1881. While en route to the meeting, he had witnessed its operations in Yates county, in this State, where it was found feeding upon the leaves of clover, to which it was said to be destructive, both the larvæ and the perfect insects combining in the attack. The extent of its depredations or its abundance was not given. The interesting fact was stated that this newly-imported European beetle had first made its appearance in the locality where the clover-root borer, *Hylastes trifolii*, also introduced from Europe, was discovered in the autumn of 1878. It was deemed probable that the two species were brought over at the same time, but that the former, from its less rapid multiplication, had hitherto escaped observation.

Description of the Beetle.

The beetle measures over four-tenths of an inch in length, is of an oval form, and of a brown color, which is paler over four rows of punctures on the sides, and sometimes upon the sutural line. The beak is rather short, broad and blunt. The thorax is smooth, elevated, traversed by three pale lines; both it and the wing-covers are clothed with short, yellowish-brown hairs, and upon the ridges of the latter are arranged a number of black scale tufts. The prominent feature of the beetle, giving to it its specific name, is the series of close punctures arranged in ten deeply impressed lines upon each wing-cover.

FIG. 78. — The punctured clover-leaf weevil, PHYTONOMUS PUNCTATUS — twice the natural size.

The Cocoon.

The singular net-work cocoon constructed by the larva for its transformations, resembling some of those made by the caterpillars of moths, is shown in Fig. 74 at *a*, and at *b* in enlargement, nearly double its natural size. These peculiar open-work cocoons are made, it is believed, by all the species of the genus. They are composed of loose threads permitting the larva or pupa to be seen through the meshes, and, according to Westwood, they are attached to the underside of various leaves.* Professor Popenœ, in his *List of Kansas Coleoptera*,† gives this account of the cocoon of an allied species, *Phytonomus eximius* Lec., which is found on leaves of *Rumex Brittannica*: "The pupal stage is passed in a cocoon spun by the larva, on the leaf-surface, usually next to a rib. The cocoon is formed of yellow-brown threads, loosely interwoven, so that the fabric resembles net-work. It is broad oval in outline. The pupa within is very nervous, and twists around rapidly when the leaf is touched." *Phytonomus comptus* (Say) spins a similar cocoon.

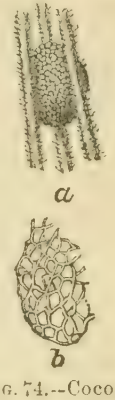

FIG. 74.—Cocoon of the punctured clover-leaf weevil, at *a*, of natural size, and at *b*, enlarged to show its reticulated structure. (After Riley.)

These net-work cocoons are not confined to the genus *Phytonomus*, for they are known to be made by *Curculio pimpinellæ*, of Europe, and also by *Cionus scrophulariæ* (Linn.), according to Westwood, occurring in both Europe and America.‡

Not Previously Known as a Clover-insect.

In Europe, where the genus is more numerously represented than in this country, two species, viz.: *P. nigrirostris* (Fabr.),§ and *P. meles* var. *trifolii*, are recorded by European authors as preying upon clover, but no mention is made of *P. punctatus* as attacking that plant. Dr. Hagen, as the result of an extended examination, informs me that he finds it not mentioned by any writer as injurious, nor any thing recorded of its history or food-plant, and that certainly up to 1871 the larva was unknown. In a list of known larvæ of Coleoptera published by Mr. Rupertsberger, in 1879, among fifteen species of *Hypera*, under which genus *Phytonomus punctatus* was formerly arranged, the

*Mr. J. A. Osborne has found the cocoons of *P.* (*Hypera*) *rumicis* as often on the upper as on the lower side of the leaf (*Entomologist's Magazine*, 1879, xvi, p. 16).

†*Transactions of the Kansas Academy of Science*, v, 1877, pp. 21–40.

‡Westwood: *Introduc. Mod. Classif. Insects*, i, 1839, p. 343. Mr. Osborne, however, states (*loc. cit.* p. 18), that all the cocoons of *C. scrophulariæ* seen by him were close and membranous, thick and tough. They are sparsely covered in the middle region with raised whitish "goose-skin" points, which appear to be produced by the subsequent filling up of small openings left in the original making of the cocoon.

§Occurs also, although rarely, in the United States, from Canada and Massachusetts westward to Michigan. (Riley.)

species is included, but no citation is given. Dr. Le Conte, whom I addressed for information, informs me that having gone nearly over the bibliography of the species, he finds no reference to its habits, except that it occurs abundantly in dry, sandy places. The insect, therefore, furnishes another illustration of a change in habits, unfortunate to us, which has frequently been found to attend the introduction of European insects into our country, whereby species, harmless in their native home, become injurious here, or if injurious there, are much more destructive when brought hither, freed from their former enemies, and with new and more favorable surroundings.

Its First Notice.

In the American Naturalist for November, 1881, Professor Riley has given an account of the operations of this insect in Yates county. It was first noticed in the latter part of April, in small patches in a clover field. By the end of July, the entire field had become badly infested, and on one portion of about two acres scarcely a whole leaf remained. Other fields in the vicinity were also attacked. The beetles were seldom seen, as they fell from the leaves as they were approached, after the habit of many of the *Curculionidæ*, and their color hardly permitted them to be recognized when on the ground. When not feeding, they hid just beneath the surface of the ground. During August and September, numerous eggs were laid by the beetles, some of them placed externally upon the plants, but the larger proportion were thrust into the old and hollow stems. A few of the larvæ which hatched from the eggs upon the plants, were nearly full-grown early in October, while those placed within the stalks, seemed, at that time, to be preparing for hibernation.

Accompanying the above statement of the habits of the insect is the following brief description of the egg and of the larva :—

The egg is elongate-oval, about twice as long as wide, pale yellow, and smooth when first laid, but becoming greenish-yellow, and roughened with hexagonal depressions before hatching. The average length is 1mm., and in most cases the larva has hatched in about one week from the time the egg was laid. The young larva is pale, with a dark head, but subsequently becomes greenish with a distinct whitish medio-dorsal line relieved by darker shades each side. The body is deeply wrinkled with prominent substigmatal and ventral swellings, the latter so well developed and so extensile that they perform the functions of prolegs giving the larva its strong resemblance to those of the *Tenthredinina*, and enabling it to easily crawl or clasp the edge of a leaf. When at rest it clings sideways and in a curved position to the leaf, usually on the underside, grasping the leaf hairs between the ventral swellings but especially in the transverse fold of the anus, by which it can hold and swing the whole body about as Syrphid larvæ are known to do. The surface of the body is sparsely beset with short stiff hairs, varying in number at different stages of growth. The largest specimen, evidently about full-grown, has up to this writing (October 3d), experienced three molts.

Still later (*Rept. Commis. Agricul.*, for the years 1881 and 1882), Professor Riley has published a detailed account of this insect — of its discovery and distribution in this country, its life-history, its natural enemies, description of its several stages, etc., to which the reader is referred for many interesting particulars. The excellent illustration accompanying the same (from which Fig. 74 was taken) is here presented (Fig. 75), by permission of the Department of Agriculture, to

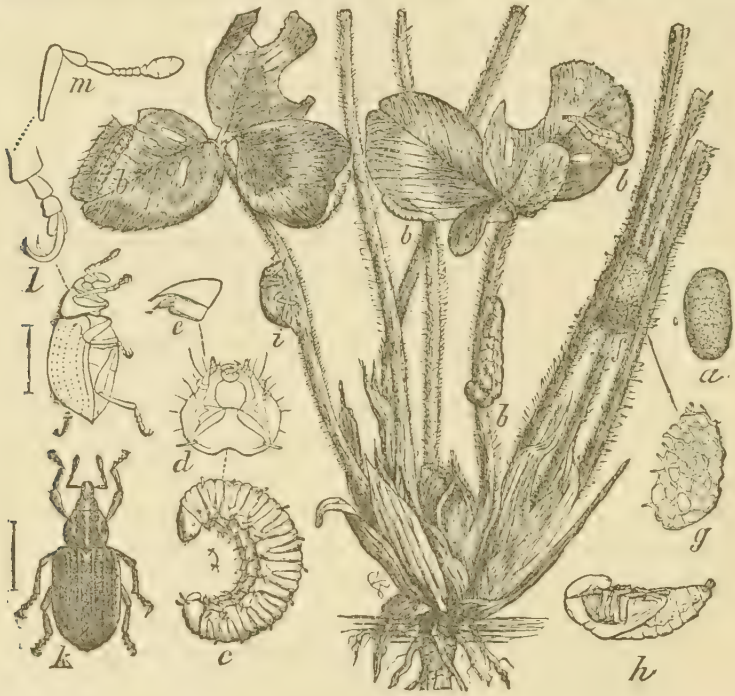

FIG. 75.—The punctured clover-leaf weevil, PHYTONOMUS PUNCTATUS; *a*, the egg, enlarged, with natural size beside it; *b*, *b*, *b*, *b*, the larva at different stages of growth, feeding; *c*, the young larva; *d*, its head from beneath, and *e*, its jaw, enlarged; *f*, the cocoon in natural size, and meshes of the same enlarged at *g*; *h*, the pupa; *i*, the beetle in natural size; *j*, side view of the beetle, and *k*, dorsal view of the same, enlarged from accompanying hair-lines; *l* and *m*, foot and antenna of the beetle, enlarged.

illustrate the earlier stages of the insect, and the character of its depredations. Its life-history, as presented, may be condensed as follows: —

Life-history of the Species.

The eggs are deposited during the latter part of summer, by the beetles which may be seen in July and August. The larvæ from them appear in September, and changing to pupæ in October, emerge as beetles in November. Some of them lay their eggs, from which the larvæ hatch and hibernate while quite small, within the old clover stems. Others of the beetles hibernate without oviposition, and lay

their eggs the following spring. The young larvæ are seen as early as April feeding upon the clover, but it is not before the latter part of May and in June that they have attained a sufficient size to render them very injurious and their depredations noticeable. At first, they feed among the folded young leaves or attached to the under side of a leaf; later they fasten to its edge, into which they eat irregular patches. The older larvæ are difficult to observe while feeding, as they are quite timid, and drop to the ground when approached. The feeding is done during the night, the day being passed in concealment among the roots and old stalks, or other shelter found upon the surface of the ground. After they have, with their increase of size, undergone three moltings, they spin up in their cocoons, placed usually a little beneath the surface of the ground. The larva remains unchanged within the cocoon for a few days, when it transforms to a pupa. About three weeks later, somewhere about the first of July, the beetle emerges.

From observations made at the Department of Agriculture at Washington, upon the insect, in confinement, during the autumn, the several periods of its different stages were found to average as follows: The egg stage, ten and a half days; first larval stage, nine days; second larval stage, eight and one-half days; third larval stage, nine days; fourth larval stage (from third molting to spinning of cocoon), twenty-five days; larva unchanged in cocoon, nine days; pupal state, thirty days. The entire time from the egg to the perfect insect, was one hundred and one days, or about three and one-third months.

During the summer, with its higher temperature, the development is doubtless considerably more rapid, as beetles were observed to emerge during the last days of June, from cocoons which had been spun about ten days previous.

Possibly not Lately Imported.

Very lately, it has been discovered by Dr. Le Conte, that a beetle which had been given to him by Dr. Melsheimer, twenty-five or thirty years ago, and which he had described in 1876 as *Phytonomus opimus*, is referable to *Ph. punctatus*, it being a variety in which the wing-covers are almost entirely gray — identical with a similar variety which is also associated with the typical form in Europe. A second one had also many years ago been received by Dr. Le Conte, from Canada. We give the description of Dr. Le Conte:—

Robust, black, densely finely punctured, and covered with gray scales, having a metallic lustre, sparsely and indistinctly pubescent. Beak one-half longer than the head, stout, curved, antennal grooves deep, suddenly flexed downward; there is a small oblique groove each side near the tip, a short nasal furrow, and another between the eyes which are transverse. The funiculus of the antennæ has the

first joint nearly as long as the second, which is nearly equal to the three following united. Prothorax subquadrate, a little wider than long, rounded on the sides in front, and feebly constricted ; disc very obsoletely channeled. Elytra much wider than the prothorax, one-half wider than long, convex, humeri prominent, striæ with large shallow punctures, interspaces somewhat convex, first, third and fifth a little more prominent. Tibiæ not mucronate, not even the front pair. Length 7.6 mm.; .3 inch.

One specimen from Pennsylvania given me by Dr. Melsheimer, under the name adopted ; another from Canada.

From the above facts, it would naturally be inferred that the species is not, as it was at first believed to be, a recent importation, but had simply been overlooked by collectors. But as so many years had passed without the occurrence of a third example, and as all at once it is discovered so abundant in a certain locality, it has been suggested that both the examples may have been obtained as cabinet specimens in exchanges with Europe and have become accidentally introduced among American species before they came into Dr. Le Conte's hands.

Distribution.

This destructive beetle has hitherto been recorded, so far as known to me, only in Yates county, N. Y., where it was first observed, and thence southwardly, into Schuyler county, near Watkins.* But the present summer (of 1882†), it has been heard of, in great numbers, in Wayne county, N. Y. Under date of July 31st, some insects were sent to me for identification, by Mr. George C. Watson, of Clyde, which were found to be this clover-weevil. It was stated in the letter accompanying them, that when first noticed, the larvæ and the beetles were feeding together, and that entire fields of clover had been destroyed by them since the removal of the hay-crop. As soon as this was removed, the insects ate every young leaf, so that the plants were apparently dead. After stripping the clover fields of the second crop, they migrated to adjoining wheat-stubble fields that had been seeded to clover in the spring, and consumed every bit of clover as they passed along. At the time of writing, their numbers appeared to be greatly diminished, and for the preceding two weeks, no larvæ had been observed.

The locality of the above attack, Clyde, Wayne county, is forty miles north of the locality in Yates county, where the beetle was first observed, and fifty miles north of the extreme southern point in the State which it appears to have reached. In Ontario county, intermediate to

Report Commis. Agriculture for 1881 and 1882, p. 173 (Schwarz).

†The long delay (of more than a year) in the printing of this report has made it desirable to incorporate with it, in this and several other instances, items of information not belonging to the period for which the report is made, but of more value in their present connection than if postponed for another year.

Yates and Wayne counties, its presence is not reported, and it is probable that it does not occur there, at least to any noticeable extent, for upon examples having been communicated to Mr. Robert J. Swan, of Geneva, with an inquiry of their presence, answer was returned that they had not been seen by him in the county, nor by Dr. Sturtevent, Director of the N. Y. Agricultural Experiment Station, at Geneva.

Should the insect continue to extend itself over the clover fields of Central New York, with the rapidity of multiplication which it has shown in the two localities where it has planted itself, it cannot fail of proving a very injurious pest.

A single example of the species was taken by me in Bennington, Vermont (five miles beyond the line of Rensselaer county, N. Y.), about the middle of August. It was not recognized at the time of its capture, nor until some weeks thereafter upon the examination of some Coleoptera which had been set aside; and after this interval the mode of its occurrence could not be recalled. It certainly was not found upon clover.

Remedies.

As the larvæ will be found most numerous in the clover fields in the month of May, it has been recommended as the best means of lessening their injuries, that the clover should be heavily rolled at that time. Plowing under badly infested fields at this time would doubtless be still more effectual. The species seems to hibernate in the young larvæ state, and if it should be found practicable to burn the stubble during the late autumn or early spring, its numbers would be materially reduced; or the same result might possibly be attained by thorough rolling, if the nature of the surface permitted recourse to this means.

Sphenophorus sculptilis Uhler.

The Sculptured Corn-Curculio.

(Ord. COLEOPTERA: Fam. CURCULIONIDÆ.)

S. sculptilis UHLER: in Proc. Acad. Nat. Sci. Phila., vii, 1855, p. 416.

S. venatus (Say), FITCH: in Count. Gent., v, 1855, p. 373, and in Cultivator for July, 1855, 3d Ser., iii, p. 221; in Count. Gent., x, 1857, p. 91; and in Cultivator, 3d Ser., v, Sept., 1857, p. 273 (an erroneous determination).

S. venatus. GEDDES: in Trans. N. Y. St. Agricul. Soc. for 1859, xix, 1860, p. 331 (determination after Fitch).

S. zeæ. WALSH: in Pract. Entomol., ii, 1867, pp. 117, 118.

S. zeæ. GLOVER: in Rept. Commis. Agricul. for 1870, (1871), p. 68.

S. zeæ. PACKARD: Inj. Ins. New and Little Known, 1870, pp. 21, 22, pl. 1, f. 11. in Hayden's Ninth Ann. Rept. U. S. G.-G. Surv. Terr., for 1875, (1877), pp. 718, 719.

S. zeæ. RILEY: Third Rept. Ins. Mo., 1871, p. 59, f. 22.
S. zeæ. HORN: in Proc Amer Philosoph. Soc., xiii, 1873, p 423, and on p. 424 as *S. sculptilis*.
S. sculptilis LE CONTE: in Proc. Amer. Philosoph. Soc., xv, 1876, p. 425.
S. sculptilis. SNOW: in Trans. Kans. Acad. Sci., v, 1877, p. 39.
S. zeæ. LINTNER: in Count. Gent., xliv, 1879 p. 439, in 39th Ann. Rept. N. Y. St. Agricul. Soc. for 1879, (1880), pp. 46–48, figs. *a b. c.*
S. zeæ. COMSTOCK: in Ann. Rept Commis. Agricul for 1879, (1880), p 248: Id for 1880, (1881), pp. 272, 273.
S. zeæ. HARRINGTON: in Ann. Rept. Ent. Soc. Ontario for 1880, (1881), p. 56, f. 42.
S. sculptilis. AUSTIN: Supp. to Ch List Coleop. N Amer, 1880, p. 54. no. 9437.
S. sculptilis. RILEY: in Amer. Naturalist, xv, 1881, p. 915; in Rept. Commis. Agriculture for 1881 and 1882, (1882), p. 139.

During the latter part of June, a number of snout-beetles (*Curculionidæ*) were sent to me from Bordentown, New Jersey, with the statement that they were proving a serious annoyance to corn fields in that vicinity. Their operations were conducted in secret, being below the surface of the ground. Upon removing some of the earth from around the young shoots of corn which were wilting and dying, from three to five of the beetles would be found, it was stated, as the cause of the injury, clinging to the shoots that they had punctured with their beaks, and from which they were extracting the juices. They were regarded as a greater evil than the common cut-worms, as they continued their ravages later, even until after the middle of June.

Different Names of the Insect.

The beetles, upon examination, were found to be a species that had been brought to notice several years ago by Mr. B. D. Walsh,* as a corn depredator, and under the belief that it was not previously known, it was named from its food-plant and described by him in the *Practical Entomologist*, as above cited, as *Sphenophorus zeæ;* but after it had been noticed by several writers under this name, as in the above references, it was discovered that it had been previously described by Mr. P. R. Uhler, under the name of *Sphenophorus sculptilis*, by which designation it is now known.

Examples of the species are in the collection of the N. Y. State Agricultural Society, placed therein and labeled by Dr. Fitch, probably about twenty-five years ago, as "*Sphenophorus venata* — the hunter weevil." As the examples are unmistakably identical with *S. sculptilis*, their naming must be regarded as an erroneous identification with the *S. venatus* of Say, which Dr. Horn regards as synonymous with *S. placidus*, *S. rectus* and *S. immunis*. These four forms were all de-

*Later, examples identical with them and having an earlier history were found by me in the State Agricultural Society collection, as mentioned.

scribed at the same time by Say, with *S. venatus* first in order; but as the insect had been more widely distributed in entomological collections as *S. placidus*, it has been thought best to retain that name for the species. It belongs to the same group of *Sphenophorus* with *S. sculptilis*, and in some of its varying forms which have given rise to its several synonyms, it so closely resembles that species, that the mistaken identification above noticed might easily have been made.

Description of the Beetle.

The accompanying figures of the insect, together with the following description (mainly from Walsh), will serve for the identification of the beetle. Its body is long, subcylindrical, about three-tenths of an inch in length; the snout or beak is nearly one-third as long as the body, of the thickness of a stout horse-hair, quite curved, slightly compressed, minutely punctured, with the tip seen from above dilated slightly and triangular. The head is black, finely punctured, with a large dilated puncture or a small oval pit between the eyes. The thorax is subtriangular, having before the middle (on the prothorax) a smooth diamond-shaped spot, on each side of which is another smooth spot of irregular shape, which, with two longer diverging spots behind, form an inverted Y on each side; the thorax elsewhere is covered with large punctures. The wing-covers are marked with rows of larger punctures placed wide apart in the grooves, represented in enlargement at *c* in Fig. 76; on the smooth places between the striæ is a row of more or less crowded punctures; on their base, near the outer edge, is a small, elongate-oval smooth spot or tubercle, and a larger one near the tip. On the tip of the abdomen beyond the wing-covers, are two short rows of stiff, fine tawny hairs. The legs are black, with the tarsi (feet) reddish-piceous. Beneath, the body is black and polished, and is marked with close punctures as large as those of the thorax.

Fig. 76.—The sculptured corn curculio, SPHENOPHORUS SCULPTILIS; *a* and *b*, dorsal and side views enlarged; *c*, a row of punctures additionally enlarged.

We have no knowledge of the earlier stages of this insect.

Earliest Notices of Injuries.

Under date of May 27, 1855, a gentleman from Solsville, Madison county, N. Y., sent to the *Country Gentleman* for examination and name, specimens of beetles, stating that they were new to him and were committing great depredations upon the young corn. Two acres had been nearly destroyed in four days. They commenced at the top of the stalk or leaf, and ate it to the ground, and sometimes to the kernel. Often from three to six were found in a hill.

Dr. Fitch, to whom the specimens were referred, in a reply sent to the *Country Gentleman*, as above cited, determined them as the species described by Mr. Say, in a tract published at New Harmony, Ind., in 1831, under the specific name of *venatus*. Dr. Fitch placed it in the genus *Sphenophorus* of Schönherr, the term, meaning *wedge-carrier*, being drawn from the shape of the body of these insects, like two wedges having their heads placed together. His attention had been called to the injuries of this insect upon young corn in Washington county, N. Y., in the middle of June of the year 1847. Upon examination, he found it engaged in its nefarious work in the corn-fields of his neighborhood, where he continued to notice its operations until into the month of July. It proved to be quite a common insect in this locality, for he had frequently found it around the edges of stones in pastures, under the fallen leaves of groves, and among the dirt in gardens, from the month of March until July.

Under date of July 24, 1857, Dr. Fitch communicated to the *Country Gentleman* that a gentleman from Bainbridge, Chenango county, N. Y., sent the beetle to him with the following statement :—

> It commences its attack when the blades of corn are only two or three inches long, and before they have unrolled, gnawing holes into them which are scarcely noticed except upon a particular examination, until after the leaves are unrolled and spread apart, when these holes become very obvious and are then mostly long and narrow, having become elongated by the lengthening of the leaf as it grows.

In a field of seven acres planted May 27th and May 28th, there was not a hill that had escaped these insects; and an adjoining field, planted a week earlier, was still more seriously injured, whilst a third field, planted a week later, wholly escaped them.

In the *Survey of Onondaga county* by Mr. George Geddes (*Trans. N. Y. State Agricul. Soc.* for 1859, xix, 1860, pp. 219–352, the following notice of the species occurs (page 331):—

> A new enemy to young corn has appeared here within a few years, the *Sphenophorus venatus* of Say, or the Hunter weevil. This insect eats the leaves of the young plants, and in some cases it has materially injured the crop. This new acquaintance may prove a formidable enemy.

In 1861, it was again reported from Onondaga county, from the town of Skaneateles, in a communication dated July 1st, as follows:—

> For the first time we are having the corn cut off by this ravenous bug. They are spreading rapidly, and their destructive propensities are about as marked as that of the locust. They first attack the root, girdling it above the seed and upper (lower ?) roots. This causes the blade to wilt as if eaten by the cut-worm. They then feed on the stalk.

The above are the only notices that we have found of the beetle at this early period. It is strange that although its injuries received the

attention of Dr. Fitch, and that two communications, at least, were made by him upon it, yet not the slightest reference is made to it in any of his Annual Reports.

It is also worthy of note, that the injuries to corn, as above given, differ materially from those published later, and hereafter to be mentioned : in the former, the beetles are said to have eaten large portions of the young leaves or to have gnawed holes into them ; in the latter, simply to have pierced or punctured the stalks.

Later Depredations.

It will be observed that nearly all the injuries from this beetle, and especially those that have been the most severe, are recorded from the State of New York, and from contiguous territory in its central portion, viz., in the counties of Ontario, Tioga, Chenango, Madison and Onondaga.

Subsequent to 1861, it seems not to have been observed during the ensuing five years. In 1867, some examples were received by Mr. Walsh, from Onondaga county, N. Y., where it was "making sad havoc with a corn-field, destroying whole fields in some instances." Later in the same year, Mr. Walsh received other specimens from Tioga county, N. Y., with the statement that they were depredating on young corn, and that the sap flowing from the wounds made by them attracted myriads of ants, whence some had erroneously supposed that they were the authors of the mischief. The beetles were noticed upon young corn for the first time, in 1866, when they were even more injurious than in 1867, in which year some fields of corn near the Susquehanna river were nearly ruined by them. They were also quite abundant and destructive at Geneva, Ontario county, N. Y. during the above years, having increased to such an extent the second year that from six to twelve of the beetles could be taken from each hill (*Rural New Yorker*, June 29, 1867). At Concord, Pa., they were reported as destroying young shoots of corn by puncturing them with their proboscis. They were found near the top of the ground. Most of the corn attacked, died, and that which survived, as the leaves unfolded, showed the punctures, which looked like shot-holes (*Practical Entomologist*, ii, 1867, p. 117).

Dr. Packard (*Injurious Insects*, etc., for 1870, p. 21), quotes from a correspondent in Tioga county, N. Y., under date of June 14, 1869, the following :—

> This is the fourth year that they have infested the newly planted corn in this vicinity. The enclosed specimens were taken on the 11th instant. I presume that they have been in every hill in my field. They pierce the young corn in numerous places, so that each blade has from one to six or eight holes of the size of

a pin, or larger, and I found a number last Friday about an inch under ground, hanging to young stalks with much tenacity. When very numerous, every stalk is killed. Some fields two or three years ago were wholly destroyed by this insect.

Subsequently, less has been heard of the ravages of this insect, and it is probable that the conditions have not continued so favorable for its multiplication. Specimens were sent to me for identification from Chesterfield, Essex county, N. Y., under date of May 30, 1879, with the statement that they were proving quite injurious to young corn, operating in the manner as above stated.

Geographical Distribution.

Dr. Packard records its occurrence at Hyannis, Mass., June 25, but not as committing serious depredations. It extends westwardly into Kansas (Snow). It is common in Illinois and Missouri, and has been received at the Department of Agriculture at Washington, from Florida and Alabama (Riley). Walsh gives its habitat as "Middle States, Georgia and Kansas," and Uhler, in its original description, "Western and Southern States."

Thought to Live in Decaying Wood.

Mr. Walsh had often met with the beetle near Rock Island, Ill., in company with several other species of the same genus, in decayed logs, floating in sloughs, and on one occasion he had found it absolutely swarming, in company with five or six other species of the genus, on the lake-beach at Chicago, close to the wood piers at the mouth of the harbor. From its occurring so abundantly in the above situations and from the other localities in the State of New York and elsewhere, where its depredations had been reported, nearly all of which were near lakes and rivers or other bodies of water, Mr. Walsh felt assured that its larvæ fed on moist wood, situated in places where it was continually washed by water, and that its great numbers upon the beach at Chicago was explicable by the larvæ having lived upon the decaying and moist wood of the large piers in the vicinity. He was "persuaded that this snout-beetle can only annoy the farmers in such situations where there is a large accumulation of decaying drift-wood, etc., in wet places, or at all events, a few miles from such situations." Prof. Riley (*Third Missouri Report*, p. 59) expresses the same opinion, based upon his belief that "the larva breeds in rotting and moist wood."

I can see no reason for supposing that the larva of this species should so far depart from what is known of the habits of the family, as to feed upon decaying wood. Westwood says of the *Curculionidæ*, "these insects are entirely herbivorous, some feeding upon leaves, others upon seeds, and some upon the stems of vegetables." Riley asserts (*Third*

Missouri Report, p. 10), of the members of the same family, "with the exception of an European species (*Anthribus varius*) whose larva was found by Ratzeburg to destroy bark-lice, they are all vegetarians, the larvæ inhabiting either the roots, stems, leaves or fruits of plants, and the beetles feeding on the same."

Wild Grass Probably its Original Food-plant.

A far more plausible explanation of the presence of the beetles upon floating wood in sloughs, swamps, lake-shores and near rivers may be offered in the supposition that the natural food of this species, in both the larval and perfect stages, is found within the stems of the coarse aquatic and swamp grasses that are natural to such localities, and that the beetles, upon emerging from their pupation within the grasses, had simply gathered upon the timber for convenient resting-places.

It is quite probable that the original food-plant of *S. sculptilis* was one or more of the following grasses : Indian rice (*Zizania aquatica*), growing on the banks and in the shallows of rivers, and abounding in the Cayuga marshes of New York* and banks of the Hudson and Susquehanna rivers ; fresh-water cord-grass (*Spartina cynosuroides*), occurring on lake shores and river banks ; blue joint-grass (*Calamagrostis Canadensis*), common in wet meadows in Central New York and elsewhere ; reed-grass (*Phragmites communis*), having the same habitat and common in the Cayuga marshes ; and (*Tripsacum dactyloides*), occurring in the Western States and probably common on the shore of Lake Michigan near Chicago, and found elsewhere in the West and South on lakes and rivers.

Although it would seem that the supply of these wild grasses could never fail of sufficing for the food of this and other curculios,† yet conditions might exist in certain years and in particular districts, as in this State in 1866–1868, when they would not be available for the deposit of the eggs and subsequent feeding. For example : It appears to be the habit of *S. sculptilis* to make its attack upon corn just at or below the surface of the ground. If unusual freshets or a very rainy spring should flood the marsh, river and lake-shore grasses, the beetle would be effectually excluded from its place of egg-deposit, just as the peach-tree borer, *Ægeria exitiosa* Say, is prevented from laying its eggs by a mound of earth of a few inches in height placed around the base of the tree. Compelled to seek other grasses for oviposition, it would naturally be attracted to Indian corn if growing in the vicinity

*Tioga county, New York, where the depredations of this insect have been unusually severe, has the Susquehanna river on its southern border, and the lakes of Central New York and these marshes to the northward.

†Dr. Le Conte informs me that he has found different species associated in feeding on the roots of a grass growing in sand hills near the ocean beach.

— one of the grasses, and the one which, from the rich nutriment that it affords, might be expected to be chosen in preference to all others, when selection is to be made.

Food-plants of Allied Species.

The larvæ of many species of the *Curculionidæ* are known to live within the stems of growing plants — some within aquatic plants: the habitat is so common that the species need not be enumerated in illustration. On two occasions, *Lixus rubellus* Rand., was observed in large numbers, in the month of September and later, in a pond in Massachusetts, clinging to the flowers and leaves of *Polygonum amphibium*, under conditions which rendered it probable that the larvæ had lived in the submerged stems of that plant. Some of the beetles which were upon the wing, alighted upon the boat of the narrator of the above occurrence, as a resting-place, it may be presumed, in the absence of other floating wood.

Habits of an Allied Species.

Of another species of the genus — *Lixus concavus* Say, its operations upon its food-plant are so much like those of *S. sculptilis* upon corn, and, we believe, indicative of what is to be hereafter learned of the method of egg-deposit of the latter, that we transcribe the account:—

Lixus concavus Say, was found on the rhubarb or pie-plant at Washington, in the act of boring into the stalk of the leaves and depositing its eggs in the holes thus made. On examining the plant, many of the leaves were found to be yellow and faded. These injured leaves mostly contained eggs, and although no larvæ were found at the time, it is highly probable that the larva of this insect causes considerable injury to the plants thus perforated, as an allied European species, *Lixus paraplectieus* is stated to reside in the stems of *Sium* or water-parsnip. (Glover: *Rept. Commis. Agricul.* for 1870, p. 71.)

Sphenophorus Larvæ Living in Corn.

Mr. Glover (ibid., p. 68) mentions a *Sphenophorus*, sent to the Agricultural Department several years previous, from South Carolina, under the local name of "bill-bug." It was not scientifically determined, and although a corn depredator, it is not probable that it was this species, for in another notice by him of the "bill-bug or corn-bug" in the *Report of the Commissioner of Patents for* 1854 — *Agriculture*, p. 67, which undoubtedly is an earlier notice of the same examples, the color of the beetle is given as "reddish-brown or reddish-black," which would not apply to *S. sculptilis;* moreover the figures given in plate 4, while approximately representing this species, do not show the quite enlarged terminal joints of the antennæ which charac-

terize it. The gentleman (Senator Evans), sending the beetles to the Department at Washington, gave the following statement of them :—

The perfect insect eats into the stalk of corn, either below or just at the surface of the ground, where it deposits its egg. After changing into a grub, the insect remains in the stalk, devouring the substance, until it transforms into the pupa state, which occurs in the same cavity in the stalk occupied by the grub. It makes its appearance the following spring in the perfect state, again to deposit its eggs at the foot of the young corn plants. These insects destroy the main stem, or shoots, thus causing suckers to spring up, which usually produce no grain, or, if any, of very inferior quality to that of the general yield. Swamp lands or low grounds are the places most generally attacked.

Mr. Glover further states that General Fitzpatrick, of Alabama, and Colonel Pitchlynn, Chief of the Choctaw nation, both corroborate the above statement of the habits of the species, and represent it as very destructive in Alabama, and on the Red river, in Arkansas, but that the planters have greatly diminished its numbers by pulling up the roots of the corn after the crop has been housed, piling them up in heaps and burning the whole mass.

Similar additional testimony of the presence of the curculio larva in the stems of corn, is given by Mr. Glover (*ibid.*, p. 68) : "A black curculio with curiously sculptured thorax, *Sphenophorus caryosus* (Oliv.), was sent from New Jersey, where it was said to be very destructive to young plants of maize in the field. It destroys them by piercing the stems, in which the larva lives and feeds."

A Species Breeding in Corn.

If the above statements of the larvæ of species of *Sphenophorus* living within the stalks of corn, from having been made by other than entomologists were not entitled to full credence, we have, quite recently, the unqualified confirmation of the statements, in the testimony of a skillful entomologist, Mr. L. O. Howard, of the Department of Agriculture. One of the larger curculios, *Sphenophorus robustus* Horn, was reported as doing considerable injury to corn in South Carolina, last year.* Mr. Howard having been sent from the Department to study its habits, found as follows :—

It actually breeds in corn. On the plantations along the bottom-lands of the Congaree and neighboring streams, as soon as the corn appears in the spring it is attacked by numbers of the adult beetles. Stationing themselves at the base of the stalk, and also burrowing slightly under the surface of the earth, they pierce the stalk and kill many plants outright, leaving others to grow up dwarfed and distorted. The whole field has frequently to be plowed over and replanted. The eggs are probably laid at this time or a little later, at or near the surface of the ground. The young larva, hatching, works downwards, and may be found at al-

**Sphenophorus pertinax* Oliv., also injures corn, in the South (Horn), and *S. parvulus* Gyll., in Missouri (Riley).

most any age in the tap-root. A few individuals work upwards into the first section of the stalk, but only, it would seem, after having consumed all available pith below ground. At full growth, the larva will have consumed the pith of the stalk for from four to five inches, dwarfing the stalk, preventing the make of the ear, and causing the lower leaves to turn brown and wither. The larva has the general characters of other described larvæ of the genus. The pupæ are found in cavities opposite the first suckers, surrounded by excrement compactly pressed so as to form a sort of cell. The beetles make their appearance in the fall (one specimen issued as early as August 30) and hibernate as adults mainly in the stalks (Riley: *American Naturalist*, xv, 1881, p. 915).

S. sculptilis has Probably Similar Habits.

In view of the above history, it would seem that there can be no longer any doubt of the breeding-place of *S. sculptilis*. Its habits and transformations will have to be those of *S. robustus*, and as soon as opportunity offers for the examination, it may confidently be expected to be discovered placing its eggs in the punctures made by its beak, or that the larva will be found within the roots during the summer, after the injuries of the imago in wounding the young shoots and causing a flow of the young sap, have ceased. Its smaller size (0.30–0.36 inch), compared with that of *S. robustus* (0.48–0.56 inch), might permit of its occupancy of our northern corn without the tangible evidence of its presence as is given in the dwarfed canes and blighted ears of the Southern fields.

The Larvæ Should be Sought for in Corn.

It is important that the life-history of this species should be satisfactorily completed, by the establishment, through actual observation, of the above habits, which, in consideration of reasons presented, we have deemed it safe to assign to it; and it will not be difficult to do so. Stalks of corn, where the operations of the beetles have been observed in the spring, should be examined after the removal of the corn in the autumn, for the detection of the pupæ, which could easily be found if therein, within their burrows, readily disclosed by sections of the stalks near the roots. If young shoots pierced by the beaks of the beetles in early spring, were carefully examined,* the eggs, if present, should be discoverable at the bottom of the punctures — the wounds, which alone have hitherto attracted attention, being made perhaps quite as much for the deposit of the eggs, as for the extraction of the sap.

The Injuries Perhaps Underestimated.

Although this corn-curculio has not been generally recognized as a serious pest, and may not be injurious over a wide extent of territory, yet, as it has an extensive distribution, extending from the Atlantic to the States beyond the Mississippi, it is not improbable that it may

*I would be glad to have some of the punctured shoots sent to me for examination.

be the unsuspected cause of much of the injury to young corn which is charged to cut-worms and other insects. When, therefore, the young shoots are observed to be injured from some not apparent cause, search should be made for this beetle beneath the ground, where, if present, by carefully removing the surface soil, it will be found, near to, or with its beak inserted in, the plant.

Remedies.

Presuming that the history of the species is now substantially known, the following recommendations may be made for the arrest of its injuries:—

First, For the destruction of the beetle: Where it is known to occur in a field, it is probable that a handful of sand, well moistened with kerosene oil and dropped around and among the shoots of a hill, will, as the oil is carried into the soil by rains, kill the beetles. If, upon examination, this should be found ineffectual, then the soil should be carefully removed by hand from the hills showing the attack, and the beetles collected and destroyed.

Second, For destroying the eggs and young larvæ: If eggs be discovered in the punctures made by the beetle, then, just as soon as the effect of the attack is observed, the shoots should be pulled up. Their speedy drying, under exposure to the sun, would probably be fatal to the contained eggs or young larvæ, but it might be more prudent to collect them and carry them from the field.

Third, For destroying the pupæ: If this precaution should be neglected and the insect be found pupating in the stalks in the autumn, then by cutting off so much of the base of the stalks as may be found to harbor them, and burning them, as was done with the Sphenophorus occurring in Alabama and Arkansas (*ante*, p. 261), all the contained pupæ may be destroyed. Unless the species breeds also in some other plant, this method would effectually arrest its spread. Mr. Glover suggested that the roots and stalks might be gathered in heaps, and quicklime applied in layers to them, which would kill the pupæ while the material would be particularly useful, upon its decomposition, as a manure where lime is needed for the soil.

Murgantia histrionica (Hahn).

The Harlequin Cabbage-Bug.

(Ord. HEMIPTERA : Subord. HETEROPTERA : Fam. CYDNIDÆ.)

HAHN : "Wanzenartigen Insecten, ii, 183, p. 116, f. 196."

STAL : "Enumeratio Hemipt., ii, p. 37, no. 4."

WALSH : in Pract. Entomol., i, 1866, p. 110; in Prairie Farmer, xviii, 1866, p. 152.

LINCECUM : in Pract. Entomol., i, 1866, p. 110 (history, habits, etc.).

GLOVER : in Rept. Commis. Agricul. for 1867. (1868), p. 71 (fig. and brief notice); Id. for 1870, p. 90 ; Id. for 1871, p. 84, f. 18 ; Id. for 1875, p. 16, f. 3 (nat. history, remedies, etc.); Ib., p. 137 (remedies); MS. Notes Journ.-Hemip , p. 68, pl. 2, f. 22 (references, localities, habits, etc.)—Prec. as *Strachia histrionicha*.

RILEY : in Amer. Entomol., ii, 1870, pp. 79, 80, 154, 155, 177 ; Fourth Ann. Rept. Ins. Mo., 1872, pp. 35–38, f. 17 (history, ravages, eggs, etc.).

BETHUNE : in Rept. Ent. Soc. Ontario for 1871, (1872), p 87.

LINTNER : in Count. Gent , xl, 1875. p. 392 (remedies) ; Id., xli, 1876, p. 565 ; Id., xliii, 1878, p. 616 (remedies, etc.) ; Id., xlv, 1880. p. 679 (description, history, remedies, etc.).

UHLER : in Bull. U. S. G.-G. Surv. Terr., i, 1876, p. 290, (p. 24 of sep. pag.), pl. 19, f. 9 ; Id., iii, 1877, p. 404.

PACKARD : in Hayden's Ninth Ann. Rept. U. S. G.-G.Surv. Terr., 1877, p. 755–757, f. 27 (habits, description, distribution, etc.).

THOMAS : Sixth Rept. Ins. Ill., [1877], pp. 59, 60 (brief general notice).

A Southern Insect.

The Harlequin Cabbage-bug is a southern insect, the first information of which came from Texas in the year 1866, when it destroyed all the cruciferous plants in a number of gardens. Since that time, it has gradually worked its way northward. Although no complaints have yet been received of its ravages in the State of New York, it has probably at the present time, judging from its observed rate of progress, made its appearance in the southern counties of the State. It is therefore important that our cabbage and turnip culturists should, in advance, inform themselves of the appearance and history of this pest, which is steadily moving toward them, in order that those who hold the advance ground of the invasion may interpose every possible impediment in the way of its permanent occupancy and its northward extension.

During the last two years, several statements have reached me from localities in Virginia and Tennessee, detailing the injuries inflicted by this bug upon cabbages, and asking for remedies against it. A correspondent from Ivy Depot, Va., under date of Sept. 24th, writes : "I

send for examination, by mail to-day, some specimens of a bug that for the last year has utterly destroyed the cabbage crop in this section, and this year, during the months of August and September, has blighted and ruined over a thousand heads of cabbage in my garden. After the cabbages are all sucked dry, the bugs attacked my summer turnips, and totally annihilated them. They then commenced to suck the bunches of late grapes, and the shoots on some of my late corn, gathering in great numbers near the young silk."

Description.

The Imago.— The above insect is a true bug, of the order of *Hemiptera* and of the sub-order of *Heteroptera*. It resembles in shape the well-known squash-bug, and feeds in the same manner by means of a beak, or proboscis, bent beneath its body when not in use. It measures three-eighths of an inch in length, by nearly one-fourth in width. It is conspicuously marked in shining blue-black, dull orange and white, as follows: The black head has two short lines upon it of yellowish-white; the thorax is orange, with a ring of black on each side, centered with a triangular orange spot, or with the black diminished, and the ring either interrupted, or broken into two spots. The coriaceous portions of the wing-covers (characterizing the *Heteroptera*), are orange, crossed obliquely by two black bands, and their tips are black. The scutel (the large triangular piece covering the central portion of the body), is black, with a pale yellow spot at each anterior angle, a black terminal tip and a central cross of orange. Beneath, the joints of the abdomen bear upon their margin a row of triangular white spots, and intermediately there are three rows of parti-colored spots in orange and white. The adult insect is represented at *f* in Fig. 77, and at *g*, with wings expanded as in flight.

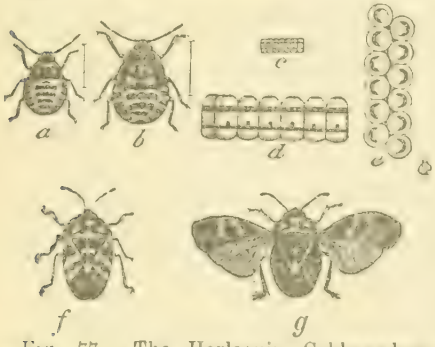

Fig. 77.— The Harlequin Cabbage-bug, Murgantia histrionica: *a* and *b*, the larva and pupa, enlarged; *c*, the eggs, natural size; *d*, side view of the eggs showing the bands; *e*, end view of same, showing the lid for the escape of the larva; *f*, the adult insect; *g*, the same, with expanded wings. (Riley.)

The Pupa.— The pupa resembles the perfect insect in marking and coloring, but may be at once distinguished by having wing-pads instead of wings: it is shown at *b*.

The Larva.— The larvæ are smaller, less angular, are without the large scutel and wing-pads, and are a pale green where the more advanced forms are orange. Their general appearance is shown at *a*.

The Eggs.— The eggs are beautiful objects, and are easily recognizable. They are cylindrical, with rounded extremities, placed on end, and cemented together by their sides. They are white, tinged with green apically, with two black bands, the upper one of which is twice as broad as the lower, and placed a little nearer to the extremity of the egg. The apex is strikingly marked with a black crescent bordering the slightly depressed lid (which opens upon a hinge for the escape of the larva), and occupying rather more than one-half of its circumference. The length of the egg is about one-half greater than its diameter, measuring 0.034 in. by 0.052 in. A cluster of the eggs, twelve in number, was found deposited within a box containing some of the bugs which had been sent to me for determination, from Nashville, Tenn., early in September. They were arranged in three rows of three, four and five eggs each. They are frequently found on cabbage leaves, placed in two rows, side by side, of six each. At *c*, in the figure, two rows of the eggs are represented in their natural size; at *d* and *e*, enlarged side and end views are given, showing the band and the apical lid.

Natural History.

The history of this insect has not been very minutely worked out The eggs are deposited upon the young plants early in spring (middle of March or earlier, in Texas), by the individuals which have survived the winter, hidden under rubbish piles and other retreats. They hatch in about six days, when the young larvæ produced by them commence feeding on the juices of the plant by means of their sharp pointed proboscis which they insert in the leaf. After feeding for a while and undergoing some moltings, the precise number of which has not been observed, with a considerable increase in size, the wing-pads make their appearance, indicating the pupal stage. Some additional moltings carry it through to its perfect state. Under favoring circumstances, the entire development of the insect, from its hatching to its final stage, is accomplished within two weeks. Eggs are deposited for a second brood, which are again followed by additional broods in the Southern States — how many, it is not known, but they continue until arrested by the advent of severe cold. At their extreme northern limit, there may not be more than two broods.

Distribution.

First noticed in Texas, in 1866, as before stated, it seems, from that time, to have been making steady progress northward. It was observed in Missouri, in 1870, and five years later, it had reached the central portion of the State. Prof. Thomas, as State Entomologist of Illinois, recorded it from Jackson county, Ill., — the latitude of the southern

boundary of Maryland. Uhler, in his List of Hemiptera of the Region West of the Mississippi, gives the following statement of its distribution :—

"It inhabits Guatemala, Mexico, Texas, Arizona, Indian Territory, California, Nevada, Colorado, and from Delaware to Florida and Louisiana. In the Atlantic region it seems to be steadily but slowly advancing northward. Its introduction into Maryland has been effected since the late war, and now [1875], it is known as far north as the vicinity of the Pennsylvania boundary-line in Delaware. In the Mississippi Valley it appears to be equally common, particularly in the States of Illinois and Missouri."

Its presence in Colorado as a serious injury to the farmers, and its occurrence at Denver, where it was observed by Prof. Uhler, proves its capability, although a Southern species, of sustaining itself even north of the isothermal line of 40° Fahr. Allowing it this range, will admit of its future extension into the Western States, at least over the southern portions of Minnesota and Wisconsin, and eastward, entirely over the States of New York and Vermont, the southern portions of New Hampshire and Maine, a large portion of the Province of Ontario, up to 48° of north latitude, and the Province of Quebec southward of a line north of the St. Lawrence River. This extension, we believe, will be only a question of time, for its progressive march seems as steady, although not so rapid, as was that of the Colorado potato-beetle. Its distribution over the northern portion of the United States cannot but operate as a serious check upon the culture of cabbage, and may prove even more disastrous than the introduction of the cabbage butterfly, *Pieris rapæ*, for the ravages of this latter insect are more within our control, and are also limited by parasitic agency.

Injuries.

The harlequin cabbage-bug is not confined to cabbages, but feeds also on turnips, radishes, mustard and other cruciferous plants, and Prof. Uhler has informed me that it also attacks cucurbitaceous plants. Mr. J. W. Moore, of Johnson Town, Northampton county, Va.,* to whom I am under obligation for information concerning this insect, has written me that last year it entirely destroyed the cabbage crop in his neighborhood, and that the present year, few cabbages having been set out, it has made sad havoc with his ruta-bagas, upon which they were still preying as late as the first of November. In only one instance have we heard of its attacking other plants than those belonging to the order of Cruciferæ — that noticed in the commencement of

*The valuable notes upon injurious insects, together with examples of rare species, from time to time communicated to me by Mr. Moore, show a cultivated observation of insects and their habits, and a highly commendable desire to aid in the advancement of economic entomology.

this article, where it was reported as injuring late grapes and corn. When cabbage leaves are punctured by them, the leaf, it is said, immediately wilts, as if some poison had been injected into it, and soon becomes quite withered. Of so serious a nature is the injury, that a half-dozen grown insects, according to Dr. Lincecum, will kill a cabbage in a day.

Difficult to Destroy.

This bug is among the number of those dreaded insects whose depredations we know not how to prevent by any of the ordinary plant applications. Sprinkling the plants with salt, lime, ashes, dust, soot, etc., has been recommended, but these and all similar means prove of very little service, as the insect easily penetrates through them into the interior to obtain its food in the unaltered juices of the plant. Even the popular insecticides — hellebore, pryethrum, Paris green, and London purple, as ordinarily applied, fail to destroy them, as the following experiments tried by me will show : Examples of the different stages, of larva, pupa and the perfect insect, were dropped into jars of the four insecticides above mentioned, and rolled over and over in the powders until thoroughly covered by them. They were then placed in separate boxes and examined from time to time. Those from the pyrethrum and hellebore jars showed for a few hours some difficulty in locomotion ; the others appeared unaffected. The following day they were all in full vigor, with the exception of a single pupa, which was in a weak condition when placed in the hellebore, and its death within a day or two thereafter may not have resulted from its hellebore dusting. The hellebore and pyrethrum had been obtained fresh from the druggist expressly for the experiments. There is no reason to believe that the above substances, if applied in water to the insects upon their food-plants, would have proved more effectual, for as they can neither be absorbed by the leaves to any appreciable extent, or the arsenic of the arsenical preparations taken up in the circulation by the rootlets, the plant-juices, upon which alone the insect subsists, cannot be affected by even such poisonous applications.

Absence of Parasites.

No parasites are known to prey upon the species, nor is there knowledge of its being eaten by poultry or any bird. It is stated (Glover's *Manuscript Notes on the Hemiptera*, p. 44), that in South Carolina, another insect, belonging to the same order of Hemiptera — *Leptoglossus phyllopus* (Linn.) — has been seen in the act of destroying it, by impaling it upon its proboscis, and sucking its juices. Unfortunately this fratricide—the murderer and the victim both belonging to the *Pen-*

tatomoidæ — has only a distribution throughout the Southern States.* but it is not impossible that it may be discovered following its prey in its northern extension. For a figure of the species, see Saunders' *Insects Injurious to Fruits* p. 386, f. 396.

Means of Destruction.

Sprinkling with hot water.— In a cabbage plat of modern extent, as in a garden, it is possible that the young bugs, while in their larval or pupal stages, may be killed by sprinkling them with hot water of as high a temperature as the young plants will bear, which may be ascertained by experimenting first upon a few plants. The thicker encasement of this insect enables it to endure a greater degree of heat than that which has been found to be sufficient to destroy the caterpillars of the cabbage butterfly, viz., 140° Fahr.

Trapping with cabbage leaves.— It is stated that the bugs have the habit of forsaking the plants on cold nights and hiding under leaves or sticks lying on the ground, and that advantage can be taken of this habit by providing them with an attractive shelter of cabbage leaves, placed between the rows, which may be lifted early in the morning, and the bugs which have sought their shelter, brushed off and destroyed. Wilted cabbage leaves appear to have a special attraction for them.

Burning rubbish piles.— It has also been recommended that, in the autumn, the waste leaves, weeds, stalks, etc., be collected in piles, to which the bugs may retire for hibernation as winter approaches. These should be examined occasionally, as soon as the nights become cold, and if many are found hidden beneath them, the piles are to be burned, and by this means the spring broods may be materially diminished.

Destroying the first broods.—Unquestionably the most reliable method of controlling this insect is to destroy the first brood. The eggs, from their being deposited in clusters, may be easily discovered on the young plants, if search be made for them, and destroyed. An easier method, however, involving less time and labor, is to destroy the young insects, by passing between the rows of the young plants every two or three days, and by a single tap with a stick knocking them into a vessel containing some kerosene oil. If, before striking the plant, it is inclined over the vessel (the insect quickly drops to the ground when disturbed), very few need escape. With the first brood thus disposed of, the subsequent depredations cannot be serious. Neglected gardens in the vicinity may send out individuals to lay the eggs for later broods, but their comparatively small number would allow of their being easily controlled.

*Uhler's *List of Hemiptera*, p. 32 of separate pagination, where also three congeneric species are given, which are also southern and western forms.

Hand-picking.— That the collection of the bugs for destruction, either by the method above given, or by the more tedious one of hand-picking is practicable and successful, is shown by the statement of Dr. Lincecum, of Texas (*loc. cit.*). "By the first of April I discovered that the insects had commenced on my radishes and cabbages, and I began picking them off by hand and tramping them under foot. By that means I have preserved my four hundred and thirty-four cabbages, but I have visited every one of them daily for four months, finding on them from thirty-five to sixty full-grown insects every day. Although many have hatched in my garden the present season, I have suffered none to come to maturity, and the daily supplies of grown insects that I have been blessed with are emigrants from other gardens." Another gentleman from the same State, in the latter part of February, 1870, gathered and destroyed, within a few days, forty-seven thousand of the bugs.

Miss Ormerod's Suggestions.

From a statement in the Fourth Missouri Entomological Report, p. 38, that "the cabbage-grower in Europe is pestered with a bug (*Strachia ornata* Linn.), which bears a general resemblance to our insect in color and ornamentation," I endeavored to obtain some information of the nature of its injuries, and the means used abroad for its destruction. In a letter from Miss Ormerod, in reply to my inquiries, she expresses regret at not being able to find any notice of its injuries except a brief note of Dr. Taschenburg (merely stating that it feeds on cabbage, has an extensive distribution, but is found in too small numbers to be regarded as injurious), or any published suggestion of remedies. In the absence of such publication she has very kindly communicated to me her ideas of what would prove serviceable in similar cases, in England, as follows :—

Noting that "the individuals which have survived the winter hidden under rubbish piles and other retreats," are the originators of the first attack of the year, I would advise as far as possible clearing all unnecessary rubbish away. I do not know how you manage in America, but here there is often a great deal of needless rubbish left about in gardens, and on the ground around wood-stacks, hay-stacks and the like, and the remains are left of such stacks to afford shelter to every kind of insect vermin. I would gather these up and burn them on the spots where they are, if possible.

When cabbage ground has been infested during summer I would *trench*,— I mean dig, turning the top portion of the ground to the bottom, so that the "bugs" may be buried so deeply that they cannot come up again : I should think that one spade deep would be enough, but two spades or as gardeners here call it, two "spits" deep, is a very thorough application.

Gas-lime applied fresh from the works is a most excellent means of killing every thing it touches, insect or plant, and I look on a

dressing of this laid on the surface of the ground when the crop is cleared off as a most useful treatment. Of course, until atmospheric action has converted the poisonous matter into sulphate of lime, it is hurtful to a serious extent to the crop, but if it can be laid on *bare* ground and so left till purified it does good by killing the insects first, and as a good manure afterward.

If objected to in this form, I should think that it might be very serviceable if thrown as a dressing, after about three months' exposure to the air, amongst the infested plants. I find this form of application very serviceable both against slugs and cabbage-moth caterpillars, ("surface" caterpillars as we call them). There is enough scent of sulphur still remaining to make the application very unpleasant to these "pests," and at this stage the gas-lime has become a safe manure.

Paraffin is being found useful here either mixed with water, or as a dry dressing in sand or ashes. Just enough paraffin to moisten the sand, not clog it, and a very small quantity of this placed around the infested plants has been found serviceable.

I think that these two remedies might be of use from their scent pervading the air, and also as they would make the ground a very unpleasant nightly resort or temporary shelter.

Pœcilocapsus lineatus (Fabr.).

The Four-Lined Leaf-Bug.

(Ord. HEMIPTERA : Subord. HETEROPTERA : Fam. PHYTOCORIDÆ.)

Lygæus lineatus FABR.: "Ent. Syst. Suppl., 1798, p. 541, no. 324; Syst. Rhyng., 1801, p. 234, no. 152."

Capsus 4-cittatus SAY: Heterop. Hemip., 1832, p. 20; in Trans. N. Y. St. Agricul. Soc. for 1857 xvii, 1858, p. 784 (description).

Phytocoris bellus EMMONS: Nat. Hist. N. Y.–Agricul., v. 1854, expl. pl. 30, f. 1.

Capsus 4-vittatus. WLSH.-RIL.: in Amer. Entomol., i, 1869, p. 246 (brief notice).

Capsus quadrivittatus. PACK.: Guide Stud. Ins., 1869, p. 550 (mention).

Phytocoris lineatus FITCH: Thirteenth Rept., in Trans. N. Y. St. Agricul. Soc. for 1869, xxix, 1870, pp. 513–522 (general account).

Capsus (Phyt.) quadrivittatus. LE BARON: First Ann. Rept. Ins. Ill., 1871, p. 61 (habits and description).

Capsus (Phyt.) quadrivittatus. SAUNDERS: in Rept. Ent. Soc. Ontario for 1871, (1872), p. 40 (food-plants and brief notice).

Lygus lineatus. GLOVER: in Rept. Commis. Agricul. for 1875, (1876), p. 125, f. 33. (brief mention); MS. Notes Journ.–Hemipt., 1876, p. 46, pl. 1, f. 9 (habits and food-plants).

Lygus lineatus. UHLER: in Bull. U. S. G.–G. Surv. Terr., iv, 1878, p. 506 (distribution); *Pœcilocapsus lineatus*, in lit., April, 1883.

Pœcilocapsus lineatus. SAUNDERS: Insects Injurious to Fruits, 1883, pp. 350–51, f. 364 (injurious to red currant).

Attack upon a Currant Bush.

During the month of June, this species was very numerous upon a black currant bush (*Ribes nigrum*) in my garden. Attention was first

called to it by the curling of the leaves, suggesting at first, as the probable cause, a serious attack by the currant Aphis, *Aphis ribes* Linn. Examination showed that instead of the characteristic bulges and blister-like elevations and brownish-red color caused by the Aphis, the leaves were more irregularly curled, and were dotted, often very closely, with small round spots, looking as if the surface had been eaten away. When, however, the real author of the injuries was detected, and its operations observed, it could be seen that the appearance produced was the result of the extraction of the parenchymal matter by means of the insect's proboscis through the puncture marking the center of each spot. If the leaf was held up to the light, a day or two after its becoming scarred, the spots were semi-transparent; later, they became partially opaque and presented a dull yellowish appearance.

The tender, terminal leaves of the bush were the first to be attacked. As they became thickly sprinkled with the spots, they dried and crumpled, and no longer giving sustenance to the bugs, they were deserted for the leaves next below on the stem. Leaf after leaf was thus attacked and injured, until a leaf entirely free from injury could, with difficulty, be found upon the entire bush — a large one — its branches spreading eight feet in extent. Only the more tender leaves toward the tips of the twigs died from their injuries, while the older and larger ones showed different degrees of drying, discoloration, and distortion.

First Notice of Attack.

The commencement of the attack of the insect was unnoticed, for it was then in its larval state, and its injuries were so inconsiderable as not to attract attention. It probably commenced its operations in the early part of May. They were first observed by me about the 10th of June. At this time, all, or nearly all, were in their pupal state: none had reached their final stage. Several of the pupæ which I had collected and confined in a glass jar with leaves to feed upon, changed to their perfect winged form on the 13th of June. The pupæ continued to be found upon the leaves until the 20th of the month, by which time, all had completed their transformations.

The Perfect Insect.

The insect is represented in Fig. 78. A careful description of it was made by me for publication — not recalling at the time, that one had already been presented by Dr. Fitch, in his *13th Report on the Insects of the State of New York*. On comparing numerous examples of the insect with his detailed description, it was found to be so remarkably exact and so elaborately complete, as to render it decidely preferable to my own. As its publication is confined to the volume in which it

was given,* and as there are many who may not have convenient access to the volume, it is herewith reproduced :—

"This bug is of an oval form, more than twice as long as wide, flattened, moderately convex both on the back and on the under side, with the surface on the upper side smooth and shining and destitute of any hairiness.

FIG. 78.—The four-lined leaf-bug (POECILOCAPSUS LINEATUS), three times the natural size.

The *head* is small, more broad than the anterior end of the thorax, but scarcely half as wide as its broadest part, four times as broad as long. Viewed in front it is triangular. In the male it is orange-red, in the female orange-yellow. The nose is represented by an elevated oblong black spot, to the lower end of which the beak or trunk is joined. This reaches slightly beyond the base of the first pair of legs. It is tapering, four-jointed, orange-yellow, the first joint black in front, the second joint black on the sides, and the last half of the fourth joint black. The eyes occupy the outer corners of the head, and are smallish, protuberant, oval, and blackish-brown. The antennæ almost equal the body in length. They are slender, tapering, bearded with fine, short, inclined hairs, black, with their basal part pale yellow. They are four-jointed, the first joint thickest and slightly longer than the width of the head, thicker toward its tip, its surface glossy and uneven; second joint more slender than the first and double its length, scarcely thicker in and beyond its middle than toward its base; third and fourth joints quite slender and thread-like, the third rather longer than the first, the fourth but half the length of the third.

"The *Thorax* is more broad than long, its sides straight and strongly converging, its base twice as broad as its apex, the basal edge straight in the middle and curving forward on each side with the outer corners bluntly rounded; the apex margined by a roundly elevated line of a lemon-yellow color, the surface convex and inclining obliquely downward and forward. Across its anterior third it is roundly elevated, smooth and polished, and of the same color as the head, this elevation having on its anterior face near its middle two shallow punctures, and commonly a similar puncture on each shoulder: and in the middle of its hind edge is a slight depression in which two shallow punctures close together may usually be seen. The remainder of the surface is minutely punctured and lemon-yellow, with four black stripes, which are larger in the males, the middle ones often as broad as long, more broad than the space between them, widening backward and almost twice as broad at their hind as at their fore ends, with their hind ends

*Trans. N. Y. St. Agricul. Soc. for 1869, xxix, 1870, pp. 517, 518.

slenderly separated from the hind edge ; the outer stripes slender and more than four times as long as broad, separated from the outer edge by a slender yellow line, and the space between them and the inner stripes nearly as wide as that between the latter. The scutel is large, triangular, lemon-yellow, sometimes orange in the males, its outer angles black, this color thus connecting the middle stripes of the thorax with those of the wing covers.

"The *wing-covers* at their base equal the thorax in width, and become slightly wider across the middle. They are of a leathery texture with the hind ends thin and membranous. The leathery portion is bright lemon-yellow, minutely and irregularly punctured, ending in a triangular piece which is separated by a transverse suture. On each wing-cover are two black stripes, continuous with those upon the thorax. Outer stripe commencing as a slender point on the anterior edge of the outer margin, gradually widening and receding nearly half its width from the margin as it extends backward, its rounded hind end commonly touching the transverse suture, and beyond this is a large black dot, upon the triangular piece slightly forward of its center. The inner stripe is usually broader than it is on the thorax, as is also the space between it and the outer stripe, whilst between it and its fellow the space is narrower here than on the thorax and scutel. The membranous ends of the wing-covers are black and united with the hind ends of the middle stripes, and the outer end of their curved vein is pale yellowish in the females. The wings are smoky black and translucent, with opake black veins.

"The *under side* is orange-yellow, in the male red, and without spots or marks in some specimens, whilst others have a black dot on each side of the breast, a black spot on the end of the body, and sometimes, forward of this spot is a short band on each segment.

"The *legs* are long and slender, the hind pair much longer than the others and their thighs thicker. They are dull yellowish-white, translucent and glossy. The thighs are long, cylindrical and bearded with fine short hairs and along their under sides a few longer ones. Toward their tips are two black bands which are sometimes united more or less, the upper band commonly broader, and on the four forward legs both bands extending but half way round. The trochanters or small smooth lobes on the base of the thighs are frequently black, and the fore thighs sometimes have an oblong black spot or cloud immediately below the trochanters. Hind thighs usually with a black line on their outer side, extending their whole length above the bands. The shanks are a third longer and much more slender than the thighs, cylindrical, bearded with small black spines, their tips

black, and a short black line on their outer side below the knee. The feet are more slender than the shanks and are three-jointed, the two first joints a little longer than thick, the last joint nearly as long as both the preceding, and black except at its base, with a pair of brown claws at its tip.

"Varieties, *a*. The outer black stripe on the thorax wanting.

"*b*. The black dot at the end of the outer stripe on the wing-covers wanting.

"*c*. The black bands above the knees wholly wanting, or replaced by one or two dots on the outer and inner sides of the hind pair."

The Pupa.

The pupæ, as in most of the Hemiptera, are equally active with the perfect insects (imagines), and feed in company with them, yet they are easily to be distinguished. They are much smaller in size. While the latter measure (average of ten examples) 0.27 in. in length, and 0.1 in. in width, the former average 0.16 in. long by 0.08 in. broad. They may at once be recognized by their wing-sheaths in the place of wings, which are black, with the exception of a pale yellow longitudinal stripe on their outer half, and reach only about one-half the length of the abdomen. The abdomen is black above on all of the eight segments visible, except on their posterior and lateral margins : beneath it is orange, with a central black streak on the last segment. The legs are pale ; the femora (thighs) are blackish at the base, with three narrow black bands near their tip ; the tibiæ (shanks) are also blackish at their base, and under a lens, numerous minute black spines may be seen ; the tarsi (feet) are black at the base and tip.

Transformation.

The change from the pupa to the perfect insect was made in so short a time, that although more than a hundred examples underwent their transformation in a glass jar upon my table where they were frequently examined, yet in only one instance was the operation detected. It proved so interesting, particularly in the attendant gradual change of color, that it was watched, and the following notes thereof taken : —

When first discovered, the pupal integument had split upon the back and separated so as to show the larger part of the thorax of the inclosed insect, the basal portion of the wings and the intermediate scutellum (♂). The characteristic and conspicuous black marks pertaining to maturity were entirely absent — the only shades observable being orange, yellow and white ; the thorax was pale yellow, the scutellum light yellow with its lateral angles orange ; the wings were white. In this condition the insect rested for a few minutes, with the

terminal half of its wings still encased in their sheaths, and with no movement other than a tremulous motion of the feet. It then turned itself around for a few times and moved several steps over the leaf, when it took position with its head directed downward, its front pair of legs holding to the leaf and the others detached. Slowly the abdomen was withdrawn from its encasement and the colorless wings from their sheaths. Soon the yellow stripes of the wings began to appear and insensibly to deepen. As yet there was no indication of the black stripes traversing the thorax and wings, or of the black of the membranaceous wing-tips.

In twenty-five minutes from the observed commencement of the transformation (at 1 o'clock as noted), the wing-tips had fully expanded. The time occupied in the disengagement from the pupal case was not noted; it could not have varied much from five minutes. At 1 h. 15 m., there were indications of the black stripes in a duskiness of color. At 1 h. 40 m., the lines had deepened to a leaden hue and the antennæ were dark. At 2 o'clock, all the stripes, the small spot toward the wing-tip, and the tip, had become blackish, and the bands on the legs were showing. When next observed, at 3 o'clock, the stripes were glossy jet black, and the mature coloring throughout had been assumed.

While change of color frequently attends insect moltings, and usually to a greater or less degree the larval molts of the Lepidoptera, it is rare that so marked a change as that above noted, ranging from white to black, can be observed, and in so brief a time.*

Continuation of the Attack.

The latter part of June (29th), the insects were still quite destructive in my garden, and had injured and disfigured a large number of plants, although effort had been made to check their depredations by daily killing numbers of them by hand. On July 16th, they were observed feeding on geraniums, the foliage of which they were rapidly destroying by the infliction of hundreds of unsightly and devitalizing blotches upon each leaf. The latest period of their continuance, owing to my subsequent absence from home for several weeks, was not ascertained

Life-History Incomplete.

It will be seen from the above account that our knowledge of the

*A thorough discussion of *color* in insects — its nature, source, production, kinds, changes, mimicry, etc., and also of *pattern* — its origin, cause, purpose and variability — presenting the most advanced knowledge upon these interesting points—may be found in a paper "On the Color and Pattern of Insects" by Dr. H. A. Hagen, published in the *Proceedings of the American Academy of Arts and Sciences*, vol. xvii (N. S. ix), 1882, pp. 234-267.

life-history of this noxious insect is still incomplete. Dr. Fitch states that they pair about the middle of June, when they lay a crop of eggs from which another generation completes its growth before the end of the season. The oviposition has not been observed. Dr. Le Baron (*loc. cit.*) states that it deposits about twenty eggs, which are oblong, subcylindrical, flask-shaped, pale with white tips. It is believed to hibernate in its perfect stage, under decaying weeds, in crevices, etc., and to come forth in early spring to deposit its eggs on the stems of the plants which are the most attractive to it.

Food-Plants.

Its first appearance in my garden was upon the black currant, as stated, from whence it seemed to spread to the surrounding vegetation, as the morning-glory, phlox, chrysanthemum, pinks, geraniums, day-lily, London-pride, sweet-pea, pig-weed, plantain and clover. Dr. Fitch records it also on red currant, raspberry, bittersweet, wiegelia, burning-bush, sumach, dahlia, snapdragon, soapwort and tansy. In addition to the above, Dr. Le Baron records it as very injurious to parsnips; Mr. Wm. Saunders, as occurring on mint and Deutzia; and Dr. D. N. De Tarr has noted its occurrence the present year in his garden, in Albany, in addition to several of the preceding, on lettuce, common pea, radish, squash, cucumber and gooseberry.

Very Injurious to Dahlias.

It would seem from the above extended list of food-plants, to be a very general feeder on garden products, and it is certainly at times very injurious to several of them. Dr. Fitch has given the following account of its injuries to one of its favorite food-plants:* "In the year 1858, I learned from A. F. Chatfield, the florist in Albany, that upon all his dahlia plants that year, when the first flower-bud put out, these bugs assembled upon it, puncturing and poisoning it so that it withered. Two or three new flower-stalks would then shoot forth from the base of this one, the buds of which would be attacked and destroyed in the same manner. Others would then put out from the bases of these, to share the same fate. Thus it went on, the whole season through. An enormously broad mass of leaves and stalks, fully three feet in diameter, thus grew from each of the dahlia roots in his garden, without a single flower from all the multitude of flower buds which had thus been developed. D. S. Heffron, of Utica, informed me that in the summer of 1864, these prettily striped yellow bugs so infested his dahlias that only three or four little imperfect flowers were produced. And in all the gardens in and around Utica that year, the

*Thirteenth Report, in *Trans. N. Y. State Agricul. Soc.* for 1869, xxix, 1870, p. 514.

flower-buds were so universally killed by this insect that no dahlias were there to be had."

Destructive to Rose-buds.

Dr. Fitch also states that he has met with this insect, puncturing the flower-buds of the rose and causing them to perish. This may be the explanation of the destruction annually in my garden of a large proportion of the buds upon several of my rose-bushes, for which I have been unable to discover any cause. Shortly after the formation of the earliest buds, a large number have been observed to turn black, and their stems for about an inch downward, also to blacken. The buds soon shrivel, dry up, and bend over toward the black shriveled stem. I have repeatedly cut open the buds and stems thus affected, and carefully examined them, without being able to find either egg or insect within them. For successive years, upon detecting this attack, I have also cut off the buds at some distance below the affected part of the stem, and inclosed them in jars, in the hope of obtaining from them the insect depredator, but without success.

Energy of Attack.

The attacks of this insect appear to be characterized, when it has attained its adult stage, by a peculiar energy or vigor through which injuries are inflicted which apparently exceed the ability of the comparatively few depredators observed in the work. While very rarely are more than two or three of the bugs seen upon a leaf, yet were its entire surface covered by them, the destruction could not be more complete. In illustration of this, the following statement of their operations upon a day-lily, as observed by me, may be of interest. They manifested an especial fondness for the tender and succulent leaves of some clusters of this plant growing in my garden, and almost before the attack upon it was observed, the foliage had been entirely destroyed. A leaf which was picked for preservation as illustrative of its work, measuring six inches in length by four broad, had, by count, between two of its veins, selected as offering an average amount of injury, one hundred and seventy-one of its characteristic markings — rounded, transparent or translucent spots, as the parenchymal matter had been more or less completely removed, varying from one-twentieth to one-tenth of an inch in diameter. As there were eighteen of these intra-nervular spaces, there is obtained for the entire number of these spots upon the leaf, three thousand and seventy-eight.

Distribution.

Unfortunately, this insect has an extensive distribution, and occurs

over a large portion of the United States, east of the Rocky Mountains. Say, when describing it fifty years ago, records it from the North West Territory, Missouri, Indiana, Pennsylvania and Georgia. Uhler mentions it as occurring in many parts of the North West on the eastern side of the Rocky Mountains. It is also recorded from Ohio (Riley), Illinois (Le Baron), Maryland (Glover), and from Ontario (Saunders).

Remedies and Preventives.

Futility of poisonous and other applications.— This yellow-lined leaf-bug being a member of the order of Hemiptera, and one of the true bugs, obtains its food, not by means of biting jaws and mastication of the leaves, but by the aid of a proboscis or sucking beak which it inserts in the tissues of stalks, stem, leaf or bud, and draws thence the juices upon which it alone subsists. It is evident, therefore, that these insects, living as they do upon the sap of plants, may not be destroyed by means of poisons applied to the surface of the stems and leaves. The delicately pointed sucker would penetrate the poison even when thickly coating the leaf, without imbibing any portion of it.

It has been thought that they could be kept from plants through applications which would be disagreeable to them, as dust, lime, ashes, soot, soap-suds, tobacco-water, carbolic-acid washes, etc. None of these, however, have, on trial, been found effectual. Cresylic-acid soap has been recommended for this purpose,* but as a series of experiments made with this material, of the extreme strength of one pound to five gallons of water, to prevent the injuries of another destructive bug of an allied genus, viz., *Lygus lineolaris* Beauv.,† proved entirely unsatisfactory, there is no reason to believe that it will be found to be of any value as against *Pœcilocapsus lineatus*.

Burning garden rubbish.— The following will be found serviceable means for arresting the depredations of this species, and the best that we are prepared to offer. The female passes the winter in sheltered places, and probably, judging from allied species, to a large extent, in decaying vegetable matter lying upon the ground : the twisted folds of dead leaves would seem to offer an excellent retreat for them. If, therefore, at the close of the season, all the dead leaves, vines, plants, bits of wood, and like worthless rubbish, be collected in piles and burned, not only will the garden be placed in suitable order for the opening of the ensuing spring, but the natural retreats of this bug, and of a number of other injurious insects of similar habits of hibernation will be broken up, and many will be burned in their hiding places. Clean culture and an annual autumnal cleaning up and destruction of all

American Entomologist, i, 1869, p. 246.

†Id. ii, 1870, p. 293.

worthless vegetable matter, cannot be too highly recommended, as aids in freeing the garden and field from the onerous tax of insect depredation.

Destroying the insect before oviposition.—As soon as the leaves of the currants, roses and other early shrubs commence to unfold in the spring — in all gardens where this insect abounded the previous year, watch should be kept for its first coming abroad from its winter quarters. Nearly all the individuals will be females, with their abdomen swollen with their burden of eggs ready to be deposited. They will be found sluggish in their movements, and their conspicuous coloring and marking render them easy to be seen. As an incentive to watchfulness now, it need only to be borne in mind, that for every one captured and killed before oviposition, there will be at least a score less of indefatigable depredators upon the choicest products of the garden throughout the early summer months, and hundreds less of the augmented later brood.

The "jarring" method and its success.— Later, when the larvæ (distinguished by the absence of wing-pads) and pupæ have collected at the tips and on the tender leaves of the plants, they should be sought for on the under side of the leaves where they hide. When occurring in such numbers that hand-picking becomes too laborious, they may be shaken in a pan of water and kerosene, and killed. This should be done in the cool of the morning, while they are comparatively inactive, and not so ready to fall to the ground at the slightest disturbance. It is important also, that as many as possible be destroyed while yet in the larval and pupal stages, during May and early June, for with the acquirement of wings they become more active, show increased timidity, and are more ready to drop from the leaves. Though for the most part, they seek safety in hiding, yet occasionally they resort to flight.

That the injuries of this insect are largely to be prevented by the methods above given, is evident from a statement made in the *American Entomologist* (vol. ii, 1870, p. 293), of the success that attended the efforts to preserve a pear orchard from the threatened destruction of its blossom buds by *Lygus lineolaris* — a species almost identical in habits to *P. lineatus*, but more numerous and of greater destructiveness. A gentleman had made various applications to his trees, and among them, cresylic soap, but without avail. "Not discouraged by this want of success, Mr. A. afterward went over all his pear trees, about two thousand in number, with a basin of soap-suds early in the morning, and shaking each branch, caused the bugs to fall into the water. It took about three hours' time of three men, and by commencing early they were enabled to get through before it became warm

enough for the bugs to become active. After pursuing this course for three successive mornings, during which time *many thousands were killed, he had the satisfaction of seeing his trees unmolested,* and thus saved."

Enchenopa binotata (Say).

The Two-Marked Tree-Hopper.

(Ord. HEMIPTERA : Subord. HOMOPTERA : Fam. MEMBRACIDÆ).

Membracis binotata SAY : in Long's Expedition to St. Peter's River, 1824, pp. 301, 302 ; American Entomology (Le Conte edit.), 1869, i, p. 201.

Membracis binotata. HARRIS : Treat. Ins. N. Eng., 1852, p. 195 ; Ins. Inj. Veg., 1862, p. 224.

Enchophyllum binotatum FITCH : in Fourth Ann. Rept. St. Cab. Nat. Hist., 1851, p. 47.

Enchophyllum binotata. EMMONS : Nat. Hist. N.Y.,–Agricul., v, 1854, pl. 13, f. 17; *Thelia binotata,* Ib., p. 156.

Enchenopa binotata FITCH : in Trans. N. Y. St. Agricul. Soc. for 1856, xvi, 1856, p. 464 : Third. Rept. Ins. N. Y., 1859, p. 146, no. 190 (generic criticism).

Enchophyllum binotatum. WLSH.–RIL. : in Amer. Entomol., i, 1869, p. 248 (food plants and habits).

Enchenopa (Membracis) binotata. GLOVER : in Ann. Rept. Commis. Agricul. for 1876, p. 28, f. 11 (description and habits).

Enchophyllum binotatum. LINTNER : in Count. Gent., xlv, 1880, p. 711, c. 1, 2 (egg-covering, food-plant, and remedies).

Enchophyllum binotatum. RILEY : in Amer. Entomol., iii, 1880, p. 254 (secretion, eggs, etc.) ; in Amer. Nat., xv, 1881, p. 574 (egg-covering).

Enchenopa binotata. SAUNDERS : Insects Injurious to Fruits, 1883, p. 242 (on grape-vines).

The Insect Infests a Bitter-sweet.

In September, a communication was received from Miss A. Goodrich, of Utica, N. Y., stating that a vine of *Celastrus scandens* (bitter-sweet) running over her front door, was infested with some enemy that was seriously injuring it. Specimens of the insect and of the infested vine were inclosed, and my attention was called to a white substance upon the bark, beneath which, it was stated, numerous minute creatures were imbedded. What was the insect, it was asked, and was the white substance a web deposited by it, and could the pest be driven away, or must the vine be destroyed.

The insect was one of our tree-hoppers, commonly known as "the two-marked tree-hopper" from the two yellow spots upon the ridge of its back, and scientifically, as *Enchenopa binotata* (Say).

There are a number of species of these hoppers, possessing the same habit of puncturing the leaves and the tender portions of various vines

and fruit-trees. From the injuries that they inflict, and the difficulty of preventing them, they are among the greatest pests of gardeners.

Description of the Insect.

Of this particular species, Dr. Harris gives the following account: "There is a little tree-hopper, which is found during the months of July and August on the wax-work, or *Celastrus scandens*, accompanied usually by its young. When fully grown, it is nearly three-tenths of an inch in length, including the horn of the thorax; it is of a dusky-brown color, with two yellowish-spots on the ridge of the back; and the first four shanks are exceedingly broad and flat. It is the two-spotted tree-hopper, *Membracis binotata* of Say. When seen sideways it presents a profile much like that of a bird, the head and neck of which are represented by the curved projecting horn of the thorax; and a group of these little tree-hoppers, of various sizes, clustered together on a stem of the wax-work, may be likened to a flock of old and young partridges. They appear to pass through all their transformations on the plant, are fond of society, and sit close together, with their heads all in the same direction." Fig. 79 represents the insect so faithfully, that by its aid, it may be readily recognized.

Fig. 79.—The two-spotted tree-hopper, ENCHENOPA BINOTATA—side and dorsal views.

Say's Original Description.

The species was originally described by Say in a Zoölogical Report, contributed by him to the Narrative of the Long Expedition to the source of St. Peter's River. From the volume in the N. Y. State Library (now quite rare) we transcribe the title,* and the original description:—

Membracis binotata.

Thorax with a compressed horn extending above the head, and two spots on the back.

Inhabits the United States.

Body fuscous, punctured; head longer than broad, rounded at tip, minutely

*Narrative | of | an Expedition | to the | Source of St. Peter's River, | Lake Winnepeek, Lake of the Woods, | &c. &c. | Performed in the year 1823, | by order of | the Hon. J. C. Colhoun, Secretary of War, | under the command of | Stephen H. Long, Major, U. S. T. E. | Compiled from the Notes of Major Long, Messrs. Say, | Keating and Colhoun, | by Wm. H. Keating, A. M., &c. | In two volumes. | Philadelphia: 1824. |

Appendix to vol. II, Part I. Natural History. § Zoölogy, by Thomas Say [pp. 253-400].

punctured ; *thorax* with a projecting horn before, which rises above the line of the back, compressed, carinated above, each side, and beneath, and incurved toward the tip; between the lateral and inferior carinæ are three elevated lines converging toward the eye; superior carina of the horn continued upon the back to the tip ; lateral carina of the horn continued upon the side to the middle of the thoracic edge ; carina of the back slightly undulated, with two yellowish spots, of which one is on the middle and the other near the tip smaller and placed nearer to the anterior one than its own length ; tip acute ; *anterior* and *intermediate tibiæ* dilated, foliaceous; *posterior tibiæ* with two serrated lines behind ; *hemelytra* opaque, much longer than the abdomen ; *wings* hardly longer than the abdomen.

Length, including the horn, seven-twentieths ; exclusive of the horn, more than one-fifth of an inch.

The eyes are nearly equidistant between the tip of the horn and of the hemelytra. It very closely resembles the *lanceolata* Fabr., an inhabitant of South America, of which it may possibly prove to be a variety.

The Egg-coverings Described.

The pieces of bitter-sweet accompanying the insects received from Utica were nearly covered, on one side with small, white masses, which at a cursory glance might be mistaken for some Coccus insect covered with its farinose secretion. Their appearance is shown in Fig. 80. They are about one-eighth of an inch long by one-tenth broad, attached to the vine by their greatest diameter, and curving upward from it to a height at the summit equal to about one-half their breadth. When touched by the finger, they are found to be quite adhesive and apparently waxy, as portions may be drawn away in long threads. Examined carefully, they show something like a lamellose structure, with the layers, ten to fifteen in number, curving slightly toward the anterior and larger end of the mass. If examined more critically under a lens, these apparent lamellæ render themselves into what might be called threads, which alternate at their meeting on the summit from the opposite sides, after the manner of a braid, as shown in Fig. 81, which presents an enlarged view of one of the masses. In some of them, the threads are not confluent throughout, but spaces occur between them, through which the bark may be seen. A section of the mass discloses an interesting structure of the lower portion, suggestive of a vertebral column and connected ribs.

Fig. 80.—Egg-coverings of the two-marked tree-hopper, Enchenopa binotata on bitter-sweet (Celastrus)

Fig. 81.—Egg-covering; enlarged to three diameters.

Some of these peculiar masses were sent by me to Professor Riley, who identified them as the *egg-coverings* of the insect above described, and subsequently gave a brief notice of them in the *American Entomologist* of October, 1880 (vol. iii, p. 254).

Nature of the Egg-covering.

The egg-covering of this insect is, in all probability, a special secretion, deposited and arranged in such manner as may best serve for a protective covering to the eggs. The insect has not, to our knowledge, been observed in the act of constructing it, nor are similar coverings, so far as we know, provided by other members of the *Membracidæ* for a like purpose, such as the Buffalo tree-hopper — *Ceresa bubalus* (Fabr.), the one-striped tree-hopper — *Thelia univittata* (Harr.), the thorn-bush tree-hopper — *Thelia crataegi* Fitch, the unadorned tree-hopper —*Smilia inornata* (Say), or the unarmed tree-hopper — *Stictocephalus inermis* (Fabr.),— all common species in the State of New York. The egg-deposits of some of these have been described, but no mention is made of any covering protecting them.

The appearance and touch of the egg-covering of *E. binotata* are so decidedly waxy, that it was but natural to believe that such was their character, for many of the insects belonging to the order of Hemiptera are known to secrete wax to such an extent that it is collected and utilized. Of the *Fulgoridæ* — a family next in place to the *Membracidæ*, Westwood says: "The species of this family emit the white waxy secretion in some cases to a remarkable extent. It is either cottony, or arranged in lamellæ, and is evidently analogous to the wax secretion of bees" (*Introduc. Class. Insects*, ii, p. 429). Some of the *Coccidæ* — an allied family — are also wax secretors. One of the species produces, from numerous secretory sacs or follicles, lodged just beneath the skin of the abdomen, the important article of commerce known as "Chinese wax," "vegetable wax," "vegetable spermaceti," or "pela." In the *American Naturalist*, v, 1871, pp. 683–685, may be found an interesting account of its production.

The material of the egg-covering of the two-marked tree-hopper* is found not to be of a waxy nature. Some pieces of the Celastrus vine bearing the masses were submitted to Dr. Hagen, and he has given me the result of his examination as follows: "The curious white cover consists of strings about 0.20 mm thick, which are composed of small bubbles or cells of about 0.016 mm diameter. A portion placed on a slide and brought over a lamp did not melt, but grew black, like coal, proving it not to be wax. When boiled with water it assumed a milky appearance, and the bubbles or cells disappeared. It is therefore simi-

*The "two-marked tree-hopper," as designated by Dr. Fitch, is preferable for the common name of this insect, that it may not be confounded with the *two-spotted* tree-hopper, *Thelia bimaculata* Fabr.

lar to the froth of *Cicada spumaria*.* dried. Each string is apparently laid separately by the insect from an apparatus near the tip of the abdomen. It is surely *albuminous*."

The above examination shows the material to be similar to that secreted by the *Cercopidæ* (next to the *Membracidæ* in a natural order), or frog-spittle insects for the shelter of their larval and the pupal forms, which may often be seen on pines, willows, grasses, and various weeds, looking exactly like masses of spittle adhering to the plants. Of these strangely housed insects which may often be met with in the State of New York, are *Aphrophora parallela* Say, *A. Saratogensis* Fitch, *A. quadrangularis* Say, *Clastoptera Proteus* Fitch, and *C. testacea* Fitch.†

Egg-Coverings Mistaken for Insects.

The general resemblance of the egg-coverings to some of the Coccus insects has been mentioned (*ante*, page 283), and it has lately been discovered that the mistake was actually made of naming two species of insects from the coverings occurring on two species of plants.

In the American Naturalist for 1881, at page 574, is this statement from Professor Riley : " In hastily looking over the collection of the late Dr. Fitch recently, we were somewhat amused to recognize the white and ribbed waxy material covering the egg-punctures of *Enchophyllum binotatum* labeled as *Dorthesia viburni* and *D. celastri*. This covering does bear a superficial resemblance to the exudations of *Dorthesia*, though a glance suffices to show that it has no structure connected with it."

The above statement leaves in doubt the actual labeling of the specimens by Dr. Fitch, and all who know the extremely careful and accurate habits of observation that characterized the distinguished entomologist, would incline to the belief that what seemed a grave blunder, would, if farther examination were made, resolve itself into a mistake of some less scientific person through whose hands the collections had passed. My attention being specially called to the matter, search was made of the writings of Dr. Fitch, outside of his regular reports, where perhaps the descriptions of the " Dorthesias " might be found, but they were nowhere to be discovered. Later, however, among the collections of the N. Y. State Agricultural Society, arranged by Dr. Fitch, evidence was found which showed conclusively that the blunder had

*"*Cicada spumaria* of Linnæus, now known as *Philænus spumarius*, was originally described from Northern Europe, but it is now known to inhabit also England, Germany and Switzerland. In this country it is found in one or other of its numerous varieties in Utah, Dakota, Sitka, Lake Winnipeg, and, on the eastern side of the continent, in Nova Scotia, Canada, Maine and New York. (Uhler.)

†For an interesting account of some of the "spittle-insects," see the *American Entomologist*, i, 1869, p. 228.

indeed been made, and incidentally, that "we are *all* liable to mistakes."

In one of the wall-cases of the collection is a branch of *Viburnum* which bears upon one side, numerous closely compacted and overlapping egg-coverings of *E. binotata*, and in the same case was a loose label (the material in the case had been repeatedly handled since its first arrangement, and very little of it ever had the labels attached), written by Dr. Fitch as follows: "Osier Dorthesia (*Dorthesia Viburni*). A scale-insect, resembling white wax, upon limbs of the Osier (*Viburnum lentago*)." In the same case is a branching specimen of about eighteen inches in length, of the bitter-sweet (*Celastrus scandens*), upon which are numerous egg-coverings, but fewer than on the Viburnum. Near it was another label, also by Dr. Fitch, with this inscription: "*Dorthesia Solani*. A wax-like scale insect which blights the Bitter-sweet (*Solanum dulcamera*)." Did Dr. Fitch subsequently discover that the particular bitter-sweet upon which these forms occurred was not the Solanum, but the Celastrus, and did he then change the specific name to *Celastri*, on other specimens labeled by him? There is no Solanum in the case, and the labels, beyond question, referred to the two above-named specimens.

There is every probability that the *Dorthesia* species of Dr. Fitch are but manuscript names, and this may be offered in palliation of the blunder, for it may be inferred that but a cursory examination was given them when named. Such an examination as would have been required for published description, could hardly have failed of disclosing their unorganized nature. The labeled specimens were placed in the Agricultural Society collection in or about the year 1868.

In Fig. 82 (after Westwood), *Dorthesia cataphracta*, of Europe, is given. A comparison of it with that of the egg-covering of *E. binotata* (see Fig. 81), will show the general resemblance that they bear to one another. Comparison may also be made with the figure of a native species of *Dorthesia* (undetermined) occurring on the burdock (*Arctium lappa*), according to Professor Comstock, in the *Report of the Commissioner of Agriculture* for 1880, plate ix, fig. 3.

FIG. 82.—DORTHESIA CATAPHRACTA, of Europe.

Eggs of the Insect.

Upon removing one of the egg-covers, a scar in the bark will show where the insect has, by means of its ovipositor, inserted its eggs. At first, the puncture thus made closes upon itself, so as to be scarcely noticeable, but later, the rupture of the circulatory vessels and an increase in the size of the eggs produces a scar which may readily be seen upon raising the covering. Upon carefully removing the bark

and portions of the adjacent tender wood, the eggs are disclosed. They will be found arranged after the same manner as in *Cicada*, inserted through a single opening, in two parallel series, separated by a small interval. There are in each row from six to twelve eggs, partly overlapping one another as in Fig. 83 *a*. They are elongate, almost cylindrical, of a delicate green color, pointed at the more deeply buried end, and rounded and of a yellowish tint at the opposite end: their form is shown at *b*. They are of so tender a character that it is hardly possible to remove them, or even to uncover them for examination without injury. Dr. Hagen has examined them microscopically, and has written me as follows of them, under date of October 28th :—

FIG. 83. — Eggs of the Two-spotted tree-hopper; *a* their overlapping position in the twig; *b*, their shape as seen in section.

I find the eggs to measure, in length 0.42—0.5mm, in breadth 0.1—0.11mm. The chorion is *very* finely transversely striated, as at *a* (Fig. 84). The contents of the egg are inclosed by a particular membrane *b*. Near the tip are three small slits, *c*, probably the micropyle. The chorion is hard and easily broken. The contents of the egg are greenish-yellow; the cells very fine.

FIG. 84. — Structure of the egg of the Two-spotted tree-hopper.

Food-plants.

The insect occurs upon many plants in addition to the bitter-sweet. Dr. Fitch (*4th Rept. State Cabinet, sup. cit.*) includes it among the species affecting the butternut, upon which it may always be found during the latter part of summer, and further states that it is common on numerous plants and trees. According to the *American Entomologist*, i, p. 248, it punctures tender grape stems and causes them to wilt : and occurs quite commonly on the red-bud (*Cercis Canadensis*), and on the hop-tree or tree-trefoil (*Ptelea trifoliata*)—the latter its favorite home. Mr. Glover (*Rept. Commis. Agricul.* for 1876), reports it as puncturing the leaves of the butternut and locust. In Maryland, it is of common occurrence on the locust. Mr. Uhler has informed me that it is known to oviposit in *Eupatorium*.*

Natural History.

The history of the insect is still incomplete. The young larvæ have been found by Professor Riley on the 10th of May. After passing their first and third molts [second not mentioned] on May 18th and June 5th, they changed to perfect insects on June 12th. The larvæ are described as being without the horn-like

American Entomologist, iii, 1880, p. 254.

projection of the thorax seen in the adult, and they appear to lack, in this stage, the ability to hop which they display later, and from which they derive their common name of "tree-hoppers."

The time of oviposition is not known. It is probably not prior to the middle of August in the State of New York, for upon the 8th of that month, I have observed the mature insect abundantly upon locust,* when none of the egg-coverings were discoverable. It may be presumed to occur during the latter half of August, for Miss Goodrich, in reply to special inquiries made, has informed me that the coverings with the eggs in the wood beneath them were first observed by her in the early part of September, upon her return to her home after an absence of most of the summer. From their fresh appearance at this time, it was quite probable that they had been quite recently placed. Her attention was drawn to them by "the extreme beauty of the web-like shields of purest white threads. Later [in October], the thread-like appearance was lost, as if by a running together of the threads."

Remedies and Preventives.

It is difficult to save from destruction a vine which has become so badly infested by this insect as the one from which the specimens were sent to me. Whenever it is evident from the numerous egg-coverings that large numbers of the eggs have been deposited, the portions most badly infested should be cut away and burned, during the autumn. The larvæ which emerge from the portion of the vine remaining, in the spring, may probably be destroyed by showering them with hot water, if care be taken to apply the water upon the sides of the vine where the insects are resting. If one prefers to incur the risk of an increase of the depredators, rather than sacrifice a large portion of the vine, the experiment might be tried as soon as convenient after the discovery of the coverings, of removing them by means of a stiff bristle-brush or otherwise. If, as there is reason to believe, the coverings are essential to the preservation and development of the eggs (perhaps exceptionally tender) then their removal, by the consequent exposure would result in the destruction of the eggs.

The insects, when they have matured and acquired wings, may be driven away before their oviposition, to other food-plants where they will prove less obnoxious, by frequently shaking the vine and not permitting them to become domesticated. They are timid creatures and easily frightened from their haunts.

*These individuals have been pronounced by Professor Uhler as a form of *E. binotata*, although differing in several particulars from examples taken upon the *Celastrus*, as in their smaller size, the larger yellow spots upon the ridge of the thorax, the anterior tip of the thorax but slightly enlarged and expanded laterally (not suggesting the head of a bird), and less curved downward toward the head.

APPENDIX.

(A.)

ENTOMOLOGICAL REPORTS OF Dr. ASA FITCH.

Upon the resumption of economic investigations of the Insects of the State of New York under legislative authority and direction, after an interval of ten years, and upon the appearance of the first of the series of annual reports upon such investigations directed to be made, it seems proper that the labors of the distinguished entomologist by whom the preceding investigations were so ably conducted during a long term of years, should be referred to, and some desirable information in regard thereto communicated.

As the entomological reports of Dr. Fitch during the years 1855-1872 constituted the first series of the kind published in this country — followed by those of Messrs. Walsh, Riley, Packard, Le Baron, Thomas and Comstock — it should be of interest to recall, after the lapse of more than a quarter of a century, the circumstances under which they had their origin, the results that they were expected to accomplish, and the character of the investigations which they were directed to embrace.

We accordingly extract from the *Transactions of the N. Y. State Agricultural Society* for the year 1854, that portion of the prefatory matter to the [First] "Report on the Noxious, Beneficial and other Insects of the State of New York," contained in pages 700–703, under the following title :*

ENTOMOLOGICAL SURVEY.

At a meeting of the Executive Committee of the New York State Agricultural Society, held at the Astor House, in the city of New York, on May 4, 1854,

Mr. Johnson stated to the Board that the Legislature had made an appropriation of $1,000 for an examination of insects, especially of those injurious to vegetation, and authorizing the appointment of a suitable person to perform the work.

On motion of Mr. Johnson, it was

Resolved, That Asa Fitch, M. D., of Washington county, be appointed to perform the work, and that he be furnished with such accommodations as he may desire, in the rooms appointed for the laboratory, in charge of the Society, and

*This does not appear in the separate editions of the Report subsequently published.

that the President and Mr. Johnson, Corresponding Secretary, be a committee to prepare instructions for said entomological examinations.

The following instructions to the Entomologist were prepared by the committee and delivered to Dr. Fitch:—

ENTOMOLOGICAL EXAMINATIONS.

The Legislature, at its last session, having appropriated the sum of $1,000, to be expended by the Society in an examination of the Insects of the State, especially those injurious to vegetation; the Executive Committee having appointed Asa Fitch, M. D., of Salem, Washington county, to make the examination, the following regulations for the guidance of the examiner were prepared by William Kelly, President, and B. P. Johnson, Secretary of the Society, the committee appointed for the purpose.

As our State has had a thorough examination made of all branches of its Natural History, except its Insects, it is of the highest importance that the remaining branch — not less in importance than the others — should receive attention. The committee feel assured that in the selection of Dr. Fitch they have secured a person every way competent to discharge the duties imposed in a manner creditable to the Society and the State.

In carrying out this examination it is desirable that equal prominence be given to economical as well as to scientific entomology, that being the part of this science which is specially important to the community at large. It has been objected to the volumes of the Natural History of the State, that they are too purely scientific in their character to be of special value to the great mass of our citizens, and in the work now to be performed it is obvious that it will be of very little consequence to know that a particular kind of moth or fly is an inhabitant of this State, unless we are also informed of its history and habits, and whether it is a depredator upon any substance which is of value to man. The habits and instincts of our insects are a proper subject of inquiry as much as their names and the marks by which they are distinguished from each other. The whole history of every noxious species should at least be traced out as fully as circumstances will permit.

The examiner is therefore directed, in the first place, to make for the present season, the insects which infest our fruit-trees the leading object of examination. Those infesting our forest-trees, our grain and other crops, our garden vegetables, our animals, etc., will remain to be particularly studied hereafter. The examiner is desired in his examinations to search out every insect which is a depredator upon our apple, plum, pear, cherry, peach, and other fruit-trees, and study out all the facts in the history of each species, both in its larva and in its perfect state, as far as he shall have opportunity to do it. In this way a broad foundation will be laid to which additions can be made, which future observations may show to be necessary.

Should any important insect depredator appear the present season in any other situation than upon the fruit-trees, the opportunity for studying it should not be neglected, for the same species may not appear again in many years under circumstances as favorable for becoming acquainted with its real history.

Secondly: What time is not necessarily occupied in examining the insects in-

festing our fruit-trees should be devoted to collecting and classifying the insects of the State, and to naming and describing such species as have not been described.

A report to be prepared at the end of the season, to be submitted to the Legislature, showing what has been accomplished during the season, to be divided into two parts. The first, upon economical entomology, giving an account of all that has been ascertained respecting the insects infesting our fruit-trees, and any other injurious species that may have been obtained. The second, upon scientific entomology, giving a systematically arranged catalogue of all the insects of the State, so far as they are known, with a brief description of such new and undescribed as may be discovered.

The work should be pursued with a view of eventually securing to the State as full and complete accounts of all the insects of this State as far as to place this important science (which is at the present so greatly in the background, and so partially and imperfectly explored upon this side of the Atlantic) in as perfect a position and as favorable a situation for being acquired as its nature will admit of. Should there be time, in addition to the above, to perform other labor, it is desired.

Thirdly: That a commencement should be made in writing out full descriptions of the species pertaining to some particular order, with observations upon the time of appearing, habits, etc., with a view of future publication, so as to secure a complete account of all the insects of the State pertaining to that order.

Lastly: Suits of specimens to fully illustrate both the economical and scientific entomology of the State should be gathered in connection with the other parts of this work, to be placed in the Cabinet of Natural History; and in the Agricultural Museum, specimens of the wood, leaves, and fruits, and other substances depredated upon by each and every species of our noxious insects, showing the galls or other excrescences which they occasion, the holes or burrows which they excavate, the webs or other coverings for themselves which they construct, with preserved specimens of the worms, caterpillars, etc., by which each of these deformities is produced.

Such further examinations as Dr. Fitch may deem necessary to carry out fully the objects desired to be accomplished, as from time to time may be deemed advisable, the committee desire may be made.

[Signed] WILLIAM KELLY,
B. F. JOHNSON,
Committee.

Under the above appointment and instructions, Dr. Fitch presented to the State Agricultural Society, his *First Report on the Noxious, Beneficial and Other Insects of the State of New York*, bearing date of March 14, 1855. It was published in the Volume of the Society's Transactions for 1854, in the year 1855. The Report having received the approbation and high commendation of a committee of the State Agricultural Society, and also a select committee of the Legislature to whom it was referred (*see Trans. N. Y. S. A. S.* for 1854, pp. 693–700), the continuance of the appropriation for carrying on the Entomological work was asked of the Legislature. It was granted, and an-

nual appropriations were made thereafter, for several successive years, and until the infirmities of an advanced age no longer permitted Dr. Fitch to continue his valued investigations.

The Fitch Reports, which have been universally held in high estimation both at home and abroad by entomologists, agriculturists, and many others, are fourteen in number. They are published in the Transactions of the State Agricultural Society, as follows :—

NUMBER OF REPORT.	Transactions N. Y. St. Agricultural Society.				
	Volume	For the Year	Published in	Current Pages	No. of Pages.
First	xiv	1854	1855	705–880	176
Second	xv	1855	1856	409–559	151
Third	xvi	1856	1856	315–490	176
Fourth*	xvii	1857	1858	687–753	67
Fifth	xviii	1858	1859	781–854	74
Sixth	xx	1860	1861	745–868	124
Seventh	xxi	1861	1862	813–859	47
Eighth	xxii	1862	1863	657–691	35
Ninth	xxiii	1863	1864	778–823	46
Tenth	xxiv	1864	1865	433–461	29
Eleventh	xxvi	1866	1867	487–543	57
Twelfth	xxvii	1867	1868	889–932	44
Thirteenth	xxix	1869	1870	495–566	72
Fourteenth	xxx	1870	1872	355–381	27

Of the above reports, the twelfth, thirteenth and fourteenth have only been published as above stated: the others have appeared separately, as follows :—

First Report | on the | Noxious, Beneficial and Other Insects, | of the | State of New York, | made to the State Agricultural Society, pursuant to an Appropriation | for this Purpose from the Legislature of the State. | — | By Asa Fitch, M. D., | Entomologist of the N. Y. State Agricultural Society; Member of the | Entomological Society of France, of Pennsylvania, etc. | — | Albany: | C. Van Benthuysen, Printer to the Legislature. | No. 407 Broadway. | 1855. | Pamph., 8vo., pp. 180, including Index. Title-page cover, and title-page. A few copies were bound in cloth.

*Appended to this Report, on pp. 755–812, Dr. Fitch has republished the following rare tract: "Descriptions of New Species of Heteropterous Hemiptera of North America, by Thomas Say. New Harmony, Indiana. December, 1831." Of this publication, only two copies were known to be extant. It was here reproduced from a transcript which Dr. Fitch had made of one of the two copies, which was in the possession of Dr. Harris. It contains 143 species.

This Report is mainly devoted (145 pages) to the insects injurious to fruit-trees, viz., the Apple, the Pear, the Peach, the Plum (1 species of insect), the Cherry, and the Grape-vine. It also notices Insects infesting the Hickory, the Pine (1 species of Insect), the Cabbage and the Gooseberry (each 1 species).

First and Second Report | on the | Noxious, | Beneficial and Other | Insects, | of the | State of New York. | Made to the State Agricultural Society, pursuant to an | appropriation for this purpose from the | Legislature of the State. | — | By Asa Fitch, M. D., | Entomologist of the N. Y. State Agricultural Society; Member of the | Entomological Society of France, of Pennsylvania, etc. | — | Albany: | C. Van Benthuysen, Printer to the Legislature. | No. 407 Broadway. | 1856. | Cloth, 8vo., pp. 336 including Index. Plates 1–4, and 37 wood-cuts not numbered in the text.

This Report treats of Insects injurious to the Apple-tree (in 75 pages); to Forest-trees (in 21 pages), viz., the Pine, Larch, Maple, and Poplar; and to Field crops, viz., Wheat, Corn, and Hops.

Third, Fourth, and Fifth Reports | [same as preceding to] | C. Van Benthuysen, Printer. | No. 407 Broadway. | 1859. | cloth, 8vo., separately paged: Third Report, pp. i–vii + 3–172, plates 1–4, 1 wood-cut: Fourth Report, pp. 1–67, 4 wood-cuts in text: Fifth Report, pp. 1–74, 9 wood-cuts in text. Index of 11 pages (unpaged) to the 3 reports, referring to the 360 sections contained therein.

The Third Report notices the Insects of our Fruit-trees (56 species of apple insects), including the nut-trees, and, in a supplement, a few miscellaneous insects: The Fourth Report, insects injurious to Evergreen Forest-trees; and the Fifth Report, the Insects of Deciduous Forest-trees.

Sixth, Seventh, Eighth and Ninth | Reports | on the | Noxious, Beneficial and other Insects, | of the | State of New York. | Made to the State Agricultural Society, pursuant | to an Annual Appropriation for this purpose | from the Legislature of the State. | — | By Asa Fitch, M. D., | Entomologist of the N. Y. State Agricultural Society; | Member of the Entomological Society of France, | of Philadelphia, the Albany Institute, etc. | — | Albany: | Van Benthuysen's Steam Printing House. | 1865. | Cloth, 8vo., pp. 260, plates 1–4, 4 wood-cuts.

The Sixth and Seventh Reports are devoted to Insects infesting Grain crops (90 pages upon the wheat-midge); the Eighth and Ninth to Insects infesting Gardens.

[Ninth] Report of Dr. Fitch on the Noxious and other Insects detrimental to Agriculture. Also an address delivered before the N. Y. Agricultural Society. Albany: C. Wendell, Legislative Printer. 1865. Pamphlet, 8vo., pp. 56, with index.

The address is upon the Hop-Aphis, referred to on page 320. The Pamphlet is not now accessible to me, and therefore the above is the only reference to it that may be made at present.

Tenth and Eleventh | Reports | [same as preceding to] Van Benthuysen & Sons' Steam Printing House. | 1867. | Pamph., 8vo., pp. 90, including Index (the Tenth Report occupies 29 pages), 18 figs.: cover with half-title, viz., Tenth and Eleventh Reports | of the | Noxious, Beneficial and other Insects. | By Asa Fitch, M. D. |

The Tenth Report contains notices of "Insects infesting Gardens" — Nos. 14–18, viz., the cucumber-beetle, the three-lined potato-beetle, the hop-aphis, the barberry-aphis, and the flattened centipede.

The Eleventh Report contains the onion-fly, *Anthomyia ceparum* Linn., the punctured flea-beetle, *Psylliodes punctulata* Mels., the cabbage-fly, *Anthomyia brassicæ* Bouché, the radish-fly, *Anthomyia raphani* Harris, the cabbage-Aphis, *Aphis brassicæ* Linn., an extended notice of wire-worms, and notices of a few other insects.

The Reports of Dr. Fitch should be, and are we believe, regarded as indispensable to the library of every American entomologist. Inquiries are frequently made of where and how they are to be procured, for unfortunately, complete series are but rarely to be met with. It will, therefore, be of service to make the following statement in relation to them, referring to the table of their publication given upon page 294.

Two or three of the bound volumes originally published,— the one containing the first and second reports, and the one containing the sixth, seventh, eighth, and ninth — may be obtained, by purchase, by addressing the Secretary of the State Agricultural Society, at Albany, Mr. T. L. Harison. The third report is only to be had at second hand as it may by chance be met with. Of the remaining ones of the series, viz., the fourth, fifth, and tenth to fourteenth inclusive, copies (of some of them only a few), in the volumes of the Transactions of the Society in which they were published (see table), are still in possession of the Society, and may probably be procured from the Secretary through purchase or exchange.

In consideration of the value of these reports and their increasing rarity, provision was made, in 1873, through an appropriation of the Legislature of the State, for their revision and republication.*

The revision was completed by Dr. Fitch and presented to the Legislature, and a resolution for printing two thousand copies under the direction of the Board of Regents of the University was passed by the Assembly,† but for some reason (it is believed from political considerations), it failed to receive the concurrence of the Senate.

*Chapter 760 of the Laws of 1873 (page 1147) appropriates fifteen hundred dollars to Dr. Fitch "for revising and completing for publication his survey of the noxious and other insects of the State."

†See Journal of the Assembly for 1875, April 16th, p. 864.

When a few years ago, it was proposed to make another effort for the publication, the manuscript could not be found, nor has the search subsequently made for it been successful: it is feared that, not having been properly cared for at the time, and through ignorance of its value, it was destroyed. As it should have been deposited in the State Library, it is still hoped that it may be brought to light in the removal of the greatly overcrowded material of the Library to the quarters being prepared for it in the New Capitol. As a possible aid to its discovery, the above somewhat circumstantial statement is made.

Miscellaneous Entomological Papers of Dr. Fitch.

In addition to the Annual Reports made to the N. Y. State Agricultural Society, as noticed in the preceding pages, the following entomological papers have been contributed by Dr. Fitch to the *Transactions of the Agricultural Society*, the *Quarterly Journal of Agriculture and Science*, the *Country Gentleman*, the *Cultivator*, and to other agricultural and scientific publications. It has not been possible to complete the list. Additions to it may appear hereafter.

1845. Insects Injurious to Vegetation.— No. 1. (American Quarterly Journal of Agriculture and Science, i, 1845, pp. 250–254, pl. 3.)

Describes and figures (in colors) the following species of Coleoptera: *Saperda* [*Oberea*] *tripunctata*, *S. bivittata*, *S. calcarata*, *Clytus* [*Glycobius*] *speciosus*, *C.* [*Cyllene*] *pictus*, *C.* [*Neoclytus*] *caprea*, *Desmocerus palliatus*, and *Purpuricenus* [*humeralis*].

1845. Insects Injurious to Vegetation.— No. 2. Insects of the genus Cecidomyia, including the Hessian Fly and Wheat Fly. (Ib., pp. 255–269.)

Gives general characters of the order of Diptera and of the family of *Tipulidæ*, with the generic features, habits, and foreign and American species of the genus *Cecidomyia*; together with a detailed description of *Cecidomyia salicis*, its galls, habits, enemies and destroyers, illustrated by a steel plate of eight colored figures.

1845. Insects Injurious to Vegetation.— No. 3. The Wheat Fly. (Id., ii, 1845, pp. 233–264.)

Discusses the insect under the following heads: Its foreign history, its domestic history, its habits, its natural enemies, artificial means for arresting its ravages, description of the clear-winged wheat-fly (*Cecidomyia tritici*), the spotted-winged wheat-fly (*C. caliptera*), and, species resembling the wheat-flies, *C. thoracica* and *C. togata*.

1846. On the Wheat Fly and Chinch Bug. (Ohio Cultivator, February 1, 1846.)

Cited from the catalogue of the Museum of Comparative Zoölogy at Cambridge.

1846. The Wheat Fly. (Transactions of the N. Y. State Agricultural Society, for 1845, v, 1846, pp. 255–290, 1 pl.)

As stated in a foot-note : "This essay originally appeared in the Quarterly Journal of Agriculture and Science, vol. ii, no. 2 ; to the editors of which acknowledgments are due for the illustration with which it is accompanied. The essay has been revised, and new paragraphs added by the author."

Also published separate ; second edition, Albany, 1846, pp. 38, pl. 1.

1846. Insects Injurious to Vegetation. No. 4. The Hessian Fly. (American Quarterly Journal of Agriculture and Science, October, 1846, iv, pp. 244–264.)

Treats of the species under the following heads ; Its introduction into America— Its civil history and bibliography — Its name and synonyms.

1847. Insects Injurious to Vegetation. No. 5. The Hessian Fly — continued. (Id., for January, 1847, v, pp. 1–27.)

Treats of its character, transformations and habits — Its parasites — Remedies — and concludes with a summary of the preceding history.

1847. Winter Insects of Eastern New York. (Id., for May, 1847, v, pp. 274–284.)

Describes the following new species of Neuroptera and Diptera : 1. *Boreus nivoriundus,* the snow-born Boreus. 2. *Boreus brumalis*, the mid-winter Boreus. 3. *Perla nivicola*,* the small snow-fly. 4. *Nemoura nivalis*, the large snow-fly or the shad-fly. 5. *Culex hyemalis*, the winter musketoe [corrected in MS. note to *Anopheles hyemalis*].† 6. *Chironomus nivoriundus*, the snow-born midge. 7. *Trichocera brumalis*, the mid-winter Trichocera. 8. *Podura nivicola*, the snow-flea.

1847. List of Noxious Insects. (Id., for September 1847, vi, pp. 145–152.)

Classified under nine headings : 1. Infesting Grain, 28 species are named. 2. Infesting Meadows and Pastures, 23 species. 3. Infesting Garden Vegetables, 38 species : some English species are included in the preceding. 4 to 9. Infesting Flowers, Orchards, Forest-trees, Domestic Animals, Dwellings, and attacking Man ; no species are mentioned. As infesting "old books, herbaria, cases of insects, old furniture, etc.," *Atropos pulsatorius* (Linn.) Leach, the book-louse, is described (page 150). As occurring "on wheat-heads, straw, grain and flour in the field, barn and mill," *Psocus tritici*, the wheat-louse, is described (page 151). As occurring "in forests on the surface of melting snow, buckets of maple sap, and pools of water," *Podura nivicola* is redescribed. As occurring on grape-vines, sucking their juice, *Otiocerus Coquebertii* Kirby, is described.

1847. The Hessian Fly : its History, Character, Transformations and Habits. (Transactions N. Y. State Agricultural Society, for 1846, vi, 1847, pp. 316–373, 1 pl. [7].)

Originally published in the *American Journal of Agriculture and Science,* vols. iv, v, and now revised by the author.

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*Is *Capnia pygmea* Burm.

†Is *Anopheles quadrimaculatus* Say.

This essay contains many details of history and habits, which are not repeated in the notice in the *Seventh Report on the Insects of N. Y.* (pp. 134–144 of 6th–9th Reports, 1865.) Remedial measures are discussed at length, under the following heads: 1. A Rich Soil. 2. A Late Sowing. 3. Grazing. 4. The Roller. 5. Mowing. 6. Fly-proof Wheat. 7. Steeps for the Seed. 8. Oats as a Decoy. 9. Wheat as a Decoy. 10. Deeply Covering the Seed. 11. Procuring Seed from Uninfested Districts. 12. Sun-drying the Seed. 13. Drawing Elder Bushes over the Young Plants. 14. Sprinkling Fine Salt, Ashes, or Caustic Lime over the Young Plants. 15. Burning and Plowing up the Infested Stubble.

The above was also printed separately, in a pamphlet, 8vo., Albany, 1846, pp. 63, 1 plate; and also, Albany, 1847, pp. 60, 1 plate.

1847. The Grain-moth — *Tinea granella.* (The Cultivator, New Series — vol. iv, January, 1847, pp. 13, 14 — 54 cm.)

Gives a general account of the species (description, habits, transformations, and remedies), with critical remarks upon the Angoumois moth, *Anacampsis? cerealella.*

1848. The Currant-Moth, *Abraxas? Ribearia.* (Transactions of the New York State Agricultural Society, for 1847, vii, 1848, pp. 461–469, 1 pl., 11 figs.)

Gives a popular description of the larva, with an account of its habits and transformations, the nature and extent of its injuries, and remedies useful against it. The insect is also scientifically described in its larval, pupal and perfect stages, under the above name, being doubtfully referred to the genus *Abraxas.* In the plate, the three stages are represented, with some structural enlargements.

1849. Catalogue of the Insects in the State Cabinet of Natural History, December 1, 1848. (Second Annual Report on the State Cabinet of Natural History, 1849, pp. 25–39.)

Gives a classified list of 608 examples, representing 358 species, of which 32 species are Lepidoptera, 30 Neuroptera, and the remainder Coleoptera. [This collection is no longer in existence, having been destroyed by *Anthrenus varius* during the subsequent twenty years.]

1850. [Insects infesting Sheep and other Domestic Animals], contained in "A Historical, Topographical and Agricultural Survey of the county of Washington." (Transactions of the N. Y. State Agricultural Society, for 1849, ix, 1850, pp. 753–944.)

Notices, popularly, the following insects, in pp. 797–804: The sheep-tick, *Melophagus ovinus; Ornithomyia avicularia,* infesting owls; the *Œstridæ* — the bot-flies of the horse, *Œstrus equi* and *Œstrus nasalis* (p. 799); the gad-fly of cattle, *Hypoderma bovis;* the sheep gad-fly, *Cephalemyia ovis* (p. 800); sheep maggots, *Lucilia Cæsar* (p. 801), *Lucilia cadaverina, Calliphora vomitoria* (p. 802), and *Calliphora fulvibarbis; Musca domestica* and *Stomoxys calcitrans* (p. 803); also remedies and preventives for sheep maggots (p. 804)

1851. Catalogue with References and Descriptions of the [New York] Insects [of the suborder Homoptera] collected and arranged for the State Cabinet of Natural History. (Fourth Annual Report on the State Cabinet of Natural History, 1851, pp. 43–69.)

The catalogue embraces all of the New York Homoptera known to Dr. Fitch, represented in 266 examples. It contains notes upon 138 species, of which 82 are described as new, occurring in the several families as follows: In the *Cicadidæ*, 4 species are noticed; *Fulgoridæ*, 14 species, of which 6 are new; *Membracidæ*, 31 species, of which 14 are new; *Cercopidæ*, 8 species — 4 new; *Tettigoniidæ*, 46 species — 32 new; *Psyllidæ*, 6 species— all new: *Aphidæ*, 26 species—18 new; *Coccidæ*, 3 species — 2 new. The following 6 genera are proposed and described: *Carynota*, *Cyrtoisa* [error for *Cyrtosia*], *Telamona*, *Helcochara*, *Erythroneura*, and *Empoa*.

1851. Wheat Insects — Joint-Worm. (The Cultivator, New Series, viii, October, 1851, pp. 321–324.)

Injuries of the joint-worm as related by a correspondent: A species of *?Capsus* observed upon the wheat: The "joint-worm" described and critically compared with the Hessian-fly worm, and with Miss Morris' wheat-midge (an undetermined species), and is found to be different from these or any known species.

1852. Cantharis vittata. (Journal N. Y. State Agricultural Society, for October, 1852, iii, p. 55 — 18 cm.)

Notes upon the striped blistering-fly, *Cantharis vittata*, which had entirely destroyed some potato vines near Albany. Remarks upon their blistering properties, with directions for collecting and preparing them for use.

1854. Apple-tree Pests — Schönherr's Weevil and the Orchard Moth. (Trans. N. Y. State Agricultural Society, for 1853, xiii, 1854, pp. 178–187.)

Account of *Pachyrhynchus Schonherri* of Kirby, identical with *Curculio Noveboracensis* of Forster, eating the buds and young twigs of apple-trees in Michigan; also, of a caterpillar stripping all the leaves from the orchards in Washington county, N. Y., which is named as *Argyrolepia pomoriana* n. sp. An allied species is described and named as *Argyrolepia sylvaticana*, or the Forest-moth. In a postscript to the above, which had been published in the *Salem Press* of July 12th, Dr. Fitch corrects an error in relation to the orchard moth, and now names it *Chætochilus pometellus*, Dr. Harris having meantime published a description of it as *Rhinosia pometella*, in a newspaper dated the 19th of July. Dr. Fitch also describes and names an associated species as *Chætochilus contubernalellus*.

Appended to the above, are two letters from Dr. Harris, in which he notices the Michigan weevil as *Ithycerus Noveboracensis* [its present name], and the "Palmer-worm" or *Rhinosia pometella*, (pp. 188–192). [Dr. Fitch was the first to describe the larva of this insect, while at the

same time he named (as *Argyrolepia pomoriana*) a moth as its parent which was quite a different insect, belonging to a different family.]

1854. Insects of Algiers from the Museum of Natural History of Paris, confided to Asa Fitch, M. D., for the Agricultural Society of New York [136 named species as per list sent].

Remarks upon the Insects named in the above List, by Asa Fitch. (Id., for 1853, xiii, 1854, pp. 369–379.)

In this paper Dr. Fitch, in remarking upon *Colias Edusa*, one of the species received, indicates as New York insects, *Colias Philodice* Godart, *Colias Chrysotheme* Boisd., *Colias Phicomone* Boisd., *Colias nastes* Boisd., *Colias santes* n. sp., and *Colias Edusa*. In the notices of the Coleoptera he gives several instances of retarded development among the *Buprestidæ*.

1855. [Entomology. No. I.]— Osage Orange Insect. (The Country Gentleman, for Jan. 18, 1855, v, p. 38 — 77 centimeters.)

The Osage-orange has been highly esteemed and extensively used in Illinois, Wisconsin and Iowa, as a hedge-plant, from its adaptation to the climate and its freedom from insect attack. White-ants have been reported as injurious to it, but it is probable that they only attack the roots after they are dead.

The insect now sent by Mr. Robert W. Kennicott, as occurring on an Osage-orange hedge in Granville, Ohio, is a species of *Lecanium*, for which if new, Mr. K. had proposed the name of *Coccus macluræ* [from the generic name of the plant, *Maclura auriantica*]. It is probably identical with the fig-tree bark-louse, *L. caricæ* of Fabricius, but if new, it should bear the name of *L. macluræ*. Dr. Fitch figures the scales and describes them, and gives their natural history, drawn from allied species. The proper remedies would be to remove the scales and scrape the branches with a wooden-bladed knife, subsequently washing with gas-tar water or fish-oil ; or, if these are not convenient, then with strong soap-suds, at intervals of a few days, two or three times. For this, the spring of the year would be the best time. The trunk and limbs, as a protection from future attack might be whitewashed, or coated over with clay dissolved in water to the consistency of thick paint.

[No notice of this Osage-orange depredator, as such, at least, appears in the New York Reports. It is probably the same insect subsequently described (in 1860) by Dr. Fitch as *Lecanium acericorticis*, from maples in Albany, and identical with the *Lecanium macluræ* of Walsh and Riley (*Amer. Entomol.*, i, 1868, p, 14), and with the species described by Rathvon (*Pennsylvania Farm Journal*, iv, August, 1854, pp. 256–258) as *Coccus innumerabilis*, now known as *Pulvinaria innumerabilis* (Rathvon).]

1855. [Entomology. No. II.]— The Hunter Weevil. (The Country Gentleman, June 14, 1855, v, p. 373 — 56 cm.= 2 cols. The Cultivator, July, 1855, Third Series, iii, p. 221 — 40 cm.)

Gives the characters of weevils, to which this insect belongs. It is identified as the *Sphenophorus venatus* of Say, described in 1831, and the

meaning of the scientific name is given. It is a common species and had been observed since 1847 by Dr. Fitch, eating the leaves of corn, and hiding under leaves and in other localities. [See *Sphenophorus sculptilis*, page 264, *ante*.]

1855. [Entomology. No. III.]—The Chinch Bug. (The Cultivator, August, 1855, Third Series, iii, p. 238 — 37 cm.)

In reply to a communication from a correspondent in Indiana, giving an extended account of the operations of the insect in corn and wheat-fields, it is identified as the chinch-bug, and speculations upon the origin of the name are offered. Originally described by Say as *Lygæus leucopterus*, it is referred by Dr. Fitch to the genus *Micropus* of Spinola. *Micropus Spinolæ* Signoret, had recently been discovered and described, from the environs of Paris.

1855. Entomology. No. IV.—The Apple Plant-Louse. (The Country Gentleman, July 19, 1855, vi, p. 48 — 84 cm. The Cultivator, Sept. 1855, Third Series, iii, pp. 278, 279 — 80 cm.)

Gives directions for communicating specimens of insects. Six species of apple plant-lice and bark-lice known, two of which are undescribed. The Apple plant-louse examined, is identical with the *Aphis mali* of Europe. Their description, natural history, secretion of honey-dew, their enemies, and remedies; of the latter are soap-suds, tobacco water, and smoke; the "Parapetticoat" of Dr. Lindley described.

1855. Entomology. No. V.—Insects which destroy Plant-Lice. (The Country Gentleman, Sept. 6, 1855, vi, p. 158 — 84 cm.)

Compares the offensive smell of a tree badly infested with the lice, to that of stale fish: Remarks upon the rapid multiplication of the aphides: The lady-bugs make the greatest havoc among them, and their method of attack and their general habits are given: A general account is given of the Aphis-lion — the larva of the lace-wing fly, of the family of *Hemerobiidæ*, which also destroys large numbers of plant-lice.

1855. Entomology. No. V, contin.—Insects which destroy Plant-Lice. (The Country Gentleman, Sept. 13, 1855, vi, pp. 174, 175 — 55 cm.)

The Syrphus fly is mentioned as the third enemy of plant-lice, and its habits narrated. They are also liable to the attack of one of the *Ichneumonidæ*, of the genus *Aphidius*. The manner of oviposition, and the development of the insect within the aphis is detailed. Gathering these plant-lice enemies by a beating net, from hedges and forests, and transferring them to infested trees, is recommended.

1855. Entomology. No. VI.—Gaylord's Wheat-Caterpillar. (The Country Gentleman, Nov. 22, 1855, vi, p. 331 — 37 cm. The Cultivator, January, 1856, Third Series, iv, p. 19 — 28 cm.)

The caterpillar feeds on kernels of wheat, when in the milk and ripe: they are described — habits are given — have long been known in Western New York, but the perfect insect is unknown. It is believed to belong to the *Platypterida*. Mr. Gaylord describes the caterpillar in *Trans. N. Y. St. Agricul. Soc.*, iii, p. 147. See also *Cultivator*, 1839,

vi, pp. 21 and 43. Differs from Dr. Harris' wheat caterpillars (Treatise, p. 354).

1855. Entomology. No. VII.—The Wheat Thrips and Three-banded Thrips. (The Country Gentleman, Dec. 13, 1855, vi, p. 385 — 84 cm.)

Specimens sent from Geneva, Wisconsin, as injuring the blossoms of wheat and clover early in July; characters of the *Thripididæ* given; their numerous food-plants; abundance, habits and injuries of the grain Thrips, *Thrips cerealium*, in England. The several stages of the Wisconsin species are described, and it is named *Thrips tritici*. A species common upon wheat in Washington county, N. Y., on the 1st of June, is described, and named *Coleothrips trifasciata*. It had been seen upon flowers of tansy [*Tanacetum vulgare*] the last of July.

1856. Entomology. No. VIII.—Cut-Worms. (Country Gentleman, March 6, 1856, vii, pp. 154, 155; continued in no. for March 15, id., p. 171 — 104 cm. The Cultivator, April, 1856, Third Series, iv, pp. 115, 116 — 78 cm.)

In reply to inquiries, states that cut-worms appear to occur in all soils. Their "biography" is given, and five different kinds are described, which have not been reared to the perfect state, so that their species are unknown. Two of our most common cut-worm moths, viz., *Agrotis subgothica* Haworth, and *Agrotis devastator* Brace, are described; and methods of subduing cut-worm ravages are given.

1856. Entomology. No. IX.—The American Vaporer Moth. (The Country Gentleman, April 3, 1856, vii, pp. 217, 218; contin. in no. for April 10, id., p. 235 — 106 cm. The Cultivator, May, 1856, Third Series, iv, pp. 154–156 — 80 cm.)

Discourses of the great beauty of the caterpillar, and describes the insect in its several stages (egg to imago). Describes its two principal parasites, viz., *Trichogramma? orgyiæ* n. sp., and *T.? fraterna* n. sp. Some of its ravages are mentioned, and for their prevention, destruction of its eggs is recommended.

1856. Entomology. No. X.—Borer in Apple Trees—The Buprestis. (The Country Gentleman, July 10, 1856, viii, p. 27 — 70 cm. The Cultivator, August, 1856, Third Series, iv, pp. 240, 241 — 51 cm.)

Gives a statement of the operations upon apple-trees of some undetermined Buprestidæ, with a general account of the thick-legged Buprestis, *Chrysobothris femorata*, and method for preventing its ravages by the use of soft soap.

1856. Entomology. No. XII.—The Rose-Bug. (The Country Gentleman, July 31, 1856, viii, p. 75 — 70 cm. The Cultivator, Sept. 1856, Third Series, iv, pp. 270, 271 — 54 cm.)

Erroneously reported as poisonous to fowls. Its favorite food-plants are mentioned, with description of the beetle, the natural history of the

insect, and its natural enemies. Remedies and preventives for its ravages, and State bounties for its collection and destruction recommended.

1856. The Joint-Worm in Barley. (Journal N. Y. State Agricultural Society, for December, 1856, vii, p. 76 — 13 cm.)

Insects destructive to Barley, in Cazenovia, N. Y., identified as *Eurytoma hordei*, for the first time noticed in this State.

1857. Entomology. No. XIII.— The Prickly Leptostylus —a Worm under the bark of Apple-Trees. (The Country Gentleman, Jan. 29, 1857, ix, p. 78 — 77 cm. The Cultivator, March, 1857, Third Series, v, pp. 77, 78 — 58 cm.)

Account of its operations as observed by Mr. Clark, in Wisconsin. Identified as the *Leptostylus aculiferus* of Say and described by Dr. Fitch. Repeated applications of soap recommended for its prevention, and suggestions made for its detection in its retreat.

1857. Entomology. No. XIV.— Insects Imbedded in the Interior of Wood. (The Country Gentleman, March 26, 1857, ix, pp. 201, 202 — 68 cm. The Cultivator, May, 1857, Third Series, v, pp. 138, 139 — 46 cm.)

Remarks upon the importance of accompanying requests for information upon insects submitted, with the statement of what is known of them. Description of the Pigeon Tremex, *Tremex Columba* Linn., in its larval and pupal stages: mention of the trees which it infests and the decay that results. No method known by which we may destroy the larvæ. Many are killed by a parasite. Attack upon a tree may be arrested by a thick straw encasement preventing egg-deposit.

1857. Entomology. No. XV.— Grasshoppers. (The Country Gentleman, July 16, 1857, x, pp. 42, 43 — 96 cm. The Cultivator, August, 1857, Third Series, v, pp. 245, 246 — cm. 70.)

Inquiries from Scott county, Minn., in relation to a grasshopper which came from the Northwest by millions, and were in June of the following year, consuming every green thing [evidently *Caloptenus spretus*]. Dr. Fitch presents a picture of locust visitations and devastations in the old world. The immature species sent to him cannot be named, although evidently not the *Acridium femur-rubrum*, which species is sometimes gregarious and migratory, and approaches the locust of the east in its ravages. Our knowledge of the means of controlling locust ravages is better than of any other insect, from the study given it from the earliest times. It is by collecting and destroying the eggs and young insects. The extent to which this has been done in Europe, China and elsewhere, is stated, and also how it may best be done.

1857. Weevil in Seeds from the Patent Office. (Journal N. Y. State Agricultural Society, for July, 1857, viii, p. 29 — 11 cm.)

Insects discovered in a package of Patent Office seed, labeled "Spring Barley from Italy," found to be the grain-weevil, *Calandra granaria*

of Linnæus. The same insect has been very destructive to seeds in the collections of the State Agricultural Society. Dr. Fitch remarks: "Schœnherr has given the generic name *Sitophilus* to this species and its kindred, but as the larva of this insect has long been known in Europe by the popular name *Calandre* from which Clairville derived the name of his genus *Calandra*, of which genus this insect must be considered the true type, we regard the name proposed by Schœnherr to be illegitimate and untenable."

1857. The May Beetle. (The Genesee Farmer, for August, 1857, xviii, 2d Ser., pp. 239–241.)

After remarks upon the importance of ascertaining the correct scientific name of an insect, a severe criticism is made upon "the disingenuous statement of Dr. Harris," that he had proposed the genus *Phyllophaga* for this insect in 1826. Before its publication in 1827, *Lachnosterna* had been designated for it by Rev. Mr. Hope. It had long been known under the specific name of *quercina*, but this must give way to *fusca* of Frohlich, under which it was described in 1792. The exceeding destructiveness of the beetle, at times, is stated, it having entirely stripped cherry and plum trees of their leaves. The larvæ, usually solitary, sometimes become gregarious, when their injuries are intensified. The insect's life-history is not known, but is believed to be analogous to that of the cockchaffer of Europe. For the destruction of the grubs, when they abound in grass-lands, the fields should be fenced, and swine turned in to root them out. For destroying the beetles, trees where they collect should be shaken for them. Some trees which gave the first night two pailfuls, gave the fifth night but two beetles.

1857. Entomology. No. XVI.— The Hunter Weevil in Young Corn.— Beetles upon, and Worms in, Potato Vines.— Gooseberry Insects. (The Country Gentleman, August 6, 1857, x, p. 91 — 35 cm. The Cultivator, September, 1857, Third Series, v, p. 273 — 34 cm.)

In reply to inquiries made from Bainbridge, N. Y., of "a new corn insect," and telling of its injuries to the young blades of corn, the insect is identified as *Sphenophorus venatus* Say, and the recommendation made that children should be employed to collect and kill the beetles. The potato beetle is recognized as the black blistering-beetle, *Cantharis atrata*, and the borer in the vine as an unknown species of *Gortyna* [now known to be *Gortyna nitela* Guen.]. The larva infesting gooseberries in Ashfield, Mass., is not identified.

1857. Wheat-Midge. (Journal N. Y. State Agricultural Society, for November, 1857, viii, pp. 67, 68 — 27 cm.)

Dr. Fitch's determination of the wheat-midge as identical with the *Cecidomyia tritici*, of Europe, had been dissented from by M. Amyot, of Paris, but was subsequently accepted by the French Entomologists. Not being accompanied in this country with any parasite, the measures are stated which have been taken for the importation of its European parasite.

1858. Entomology. No. XVI, bis.— Experiments. Soap on Apple-Trees.—Powdered Charcoal on Cucumber Plants. (The Cultivator, August, 1858, Third Series, vi, pp. 238, 239 — 43 cm.)

Abraxas? ribearia identified, as sent from Ilion, N. Y., and reference made to its description in *Trans. N. Y. St. Agricul. Society* for 1847, p. 461 ; hand-picking recommended for its destruction. The efficacy of the soap protection of apple-trees from the borer, *Saperda bivittata*, having been questioned, Dr. Fitch experimented with it, with the following results: in twelve trees not soaped, twenty-four borers had been discovered during the year, while in twenty-two soaped trees, not one borer could be detected. Powdered charcoal failed to protect from the cucumber-beetle, while boxes open at top and bottom gave effectual protection, as also against "the cut-worm, the large stinking squash-bug, and all [?] other insect depredators."

1858. Entomology. No. XVII — The Fall Web-Worm. (The Cultivator, November, 1858, Third Series, vi, pp. 341, 342 — 55 cm.)

The insect was extremely abundant the present year. Its scientific name in both genus and species, means "the weaver." The moth is briefly described, its natural history given, together with its larval habits and the construction of its web. It prefers for food the ash, and next in order, cherry, walnut, plum, apple and willow. There are two other Ermine moths. While *Hyphantria textor* is spotless, *H. punctata* n. sp., has a black dot on the center of each front wing (*Trans. N. Y. St. Agricul. Soc.*, for 1856, p. 383), and *H. cunea*, of Drury, has numerous small black spots on the front wings.

1858. Wheat-Midge. (Transactions N. Y. State Agricultural Society, for 1857, xvii, 1858, pp. 319, 320.)

Extract from a letter of Dr. Fitch, narrating a comparison made by the distinguished French entomologist, M. Amyot, of our wheat-midge with the *Cecidomyia tritici* of Europe, and the pronounced identity of the two. Also, absence of any wheat-midge parasites in this country, and steps taken for their importation from Europe.

1858. Say's Heteropterous Hemiptera. (Transactions N. Y. State Agricultural Society, for 1857, xvii, 1858, p. 754.)

Preface to description of new species of Heteropterous Hemiptera of New York, by Thomas Say, New Harmony, Indiana. December, 1831 (Ib., pp. 755–812). Printed from a transcript copy made by Dr. Fitch from one of the two copies known to be extant.

1859. Entomology. No. XVIII. — The Golden Tortoise Beetle. (The Country Gentleman, Jan. 20, 1859, xiii, p. 50 — 66 cm.)

Gives its operations on convolvulus and other food-plants, characters of the family of tortoise-beetles or *Cassididæ*, and generic distinctions. Describes, with figures, this species, *Coptocycla aurichalcea*, of which *C. punctata*, although an older name, should be regarded as a synonym, for reasons given.

1859. A New Barley Insect. (Journal N. Y. State Agricultural Society, for April, 1859, x, pp. 114, 115 — 25 cm.)

From infested barley-straw sent from Cazenovia, N. Y., sixty flies were obtained which are of a different species from the *Eurytoma hordei* of Dr. Harris. The name *Pteromalus? tritici* is proposed for it.

1859. A New Barley Insect. (The Country Gentleman, April 21, 1859, xiii, p. 250 — 20 cm.)

From some barley joints, received from Cazenovia, N. Y., sixty examples of *Chalcididæ* were bred, of one species, one-fourth of which were males, and no parasites among them. They are found to be quite uniform, and different from the Massachusetts barley-fly, and both species different from the Virginia joint-worm. They are the only insects of the family yet discovered which feed on vegetation, all the other species being parasitic on other insects. They appear to be more nearly allied to *Pteromalus* than to *Eurytoma*, where placed by Dr. Harris.

The distinctive features of the three species, viz., the black-legged or Massachusetts Barley-fly (*Pteromalus? hordei* Harris), the joint-worm fly (herein named *Pteromalus? tritici*), and the yellow-legged Barley-fly (*Pteromalus? fulvipes*), are briefly given, in advance of publication in next Annual Report.

1859. The Thousand-Legged Worm. (The Country Gentleman, July 14, 1859, xiv, p. 27 — 16 cm.)

Reply to an inquiry, from Armstrong county, Pa., of a worm killing the young cucumber, radish, beans, onions, and the large strawberry: the latter, when near ripe, often contains fifty of them. They had been destroyed by hot water after drawing them by *thousands* beneath boards laid on the walks in the evening. Dr. Fitch could not determine the species, not having studied the group. They belonged to the genus *Julus*, and are usually regarded as inoffensive, living only on decaying matter, as *Julus Americanus* Beauv., our largest species, often found in old rotten logs. Hardly a bucket of water had been drawn from Dr. Fitch's well during the season that did not have one or two of these worms in it, which had crawled from their retreats among the stones, and fallen in. When discovered in garden vegetables, they are probably attracted by decay or putrefaction following some insect attack. The strawberries may have been first eaten by ants or other insects.

1859. Entomology. No. XIX.—Beetles Infesting Grape-vines. (The Country Gentleman, Sept. 15, 1859, xiv, p. 171 — 56 cm.)

In reply to inquiries from Westfield, N. Y., describes and figures the spotted Pelidnota (*Pelidnota punctata*); describes the Light-loving Anomala (*Anomala lucicola*) with its varieties, viz., the Gloomy Anomala (*mœrens* Fabr.), the Spotted-necked Anomala (*maculicollis*), the true Light-loving Anomala (*lucicola* Fabr.), and the Black Anomala (*atrata* Fabr.); notices briefly the Rose-bug (*Macrodactylus subspinosus*), and cites the conflicting evidences that fowls do and do not eat it; gives the natural history of the grape-vine flea-beetle (*Haltica chalybea*), and recommends as a remedy, that the beetles be searched for in their retreats and destroyed early in the spring.

1859. Entomology. No. XX.—The Parasitic Destroyer of the Curculio. (The Country Gentleman, Oct. 6, 1859, xiv, p. 221 — 60 cm.)

The Curculio regarded as our most injurious insect; at first, in 1746, it seemed confined to nectarines, later it attacked the plums, and still later, apples and cherries. A parasite had lately been received from St. Catharines, Canada West, with its history as observed. It is an internal parasite, and of this class, the "four very extensive families named *Ichneumon*, *Bracon*, *Chalcis* and *Proctotrupes*" are compared by their venation and other features, with a figure of the wing of the curculio parasite in illustration. The new parasite belongs to the Bracon family, and is shown to be a *Sigalphus*, and the specific name of *curculionis* is deemed an appropriate one. Its description with figure is given, together with its habits and operations as drawn from those of allied known species. The black-knot, in which this parasite is bred, is a vegetable fungus analogous to the smut on corn.

1859. Maple Leaf-Cutter. (The Country Gentleman, Ib., p. 225 — 11 cm.)

In reply to inquiries made of some insects sent from North Clarendon, Vt., the examples are identified as *Ornix acerifoliella* Fitch, described in the Second Report on N. Y. Insects (pp. 269–273 of 1st and 2d Reports). [The species has been subsequently referred to the genus *Incurvaria* of Haworth. Lord Walsingham thinks that *Tinea iridella* Chambers (*Canad. Ent.*, 1873, v, p. 86), may be the same insect.]

1860. Address, on our most Pernicious Insects, delivered at the Annual Meeting [of the State Agricultural Society], February, 1859. (Transactions N. Y. State Agricultural Society, for 1859, xix, 1860, pp. 588–598.)

Treats of five species of wheat insects, viz., the Wheat-midge, Grain weevil, Hessian fly, Joint-worm, and Chinch-bug; and four of fruit trees, viz., the moth of the apple-tree caterpillar, the apple-tree borer, the peach-tree borer, and the Curculio.

1860. Address of Asa Fitch, M. D., Entomologist of the Society, on the Curculio and Black Knot on Plum Trees. (Transactions N. Y. State Agricultural Society, for 1859, xix, 1860, pp. 599–612.)

The Curculio thought to be our most injurious insect. It was first noticed near Philadelphia, in 1746, but we are still ignorant of its life for three-fourths of the year. The beetle is described, and its earliest appearance abroad said to vary from 1st of April to middle of May. It continues until late in autumn. An account of the nature of its injuries in various fruits is given. A new brood appears in July, some of which oviposit in the black-knot. The excrescence is described; on its surface the fungus, *Sphæria morbosa*, is always found. But the black-knot itself, is not a fungus, nor is it produced by insect attack. Later, it is believed that the curculio oviposits in the bark of plum-trees and butternut-trees Its only known parasite, *Sigalphus curcu-*

lionis, had recently been discovered and described. For remedies, the jarring method was not sufficient. Showering, at first appearance of the curculio, with whale-oil soap and tobacco-water is recommended. Plum-trees bordering water-courses have escaped attack.

1860. The most Pernicious Species | of | United States Insects, | and | the Curculio, | two Addresses delivered at the Annual Meetings of | the New York State Agricultural Society, | A. D., 1859 and 1860 | — | by Asa Fitch, M. D., | Entomologist of the Society. | — | Albany. | Printed by C. Van Benthuysen. | 1860. | Pamph. with half title cover, pp. 28.

Published as a separate of the two preceding papers.

1860. Ravages of Insects on Forest and Fruit Trees — Remedy. (Transactions N. Y. State Agricultural Society for 1859, xix, 1860, pp. 775, 776.)

Notice of a Scale-insect infesting trees in Albany, believed to be a new species and named by Dr. Fitch as *Lecanium acericorticis*. [This species is now accepted as identical with *Pulvinaria innumerabilis* (Rathvon), for an admirable article upon which by the late J. Duncan Putnam, see the *Proceedings of the Davenport Academy of Natural Sciences*, ii, 1880, pp. 295–347, pl. xii, xiii.]

1860. Entomology. No. XXI. — Locust Leaf-miners. (The Country Gentleman, February 2, 1860, xv, p. 82—40 cm.)

Describes and figures the mines in locust leaves sent from Plymouth, Md., which are large and irregular, and have only the upper layer of the parenchyma eaten. Such mines had not been seen by Dr. Fitch and the insect therefore could not be determined. The eggs had been placed on the underside of the leaf, in the angles where the principal veins branch from the midvein. At first the young larva feeds on the lower parenchyma, which it deserts for the upper layer, the excavated portion below showing subsequently as a small brown spot on the lower surface of the leaf. It probably leaves the leaf for its final transformation. It may possibly be the Locust Hispa, *Anoplites scutellaris*, of whose operations no account had been given. It cannot be the Flattened locust leaf-miner, *Anacampsis Robiniella*, or the slender locust leaf-miner, *Argyromiges Pseudacaciella* [both of Fitch], which, although they form a similar white blister-like spot on the surface of a leaf, yet it is always on the lower surface, it being the lower layer of the parenchyma which their larvæ eat.

1860. The Entomologist. No. XXII.—The Seventeen-Year Cicada. (The Country Gentleman, March 29, 1860, xv, p. 210—50 cm.)

Newspapers are announcing the coming of the 17-year locust the present year. The name of locusts and grasshoppers are synonymous. Their multiplication and ravages, at times, were well known. The name of locust had probably been given to the 17-year cicada by the first European settlers, when they were alarmed by their numbers and noise when seen for the first time. The name of *locust*, as applied to them, should be discarded for that of *cicada*, but the desirable change

may not be accepted, so long as the wheat-midge continues to be called the "weevil." The protracted larval stage of the cicada is most remarkable. Linnæus, with his usual felicity in application of names, should have designated it as *Cicada Methuselah*. The regularity of its almost simultaneous appearance is also remarkable. It is desirable that the geographical extension of the coming brood should be ascertained, so that its future visitations may be definitely predicted. The time of appearance of other broods is mentioned, and reference is made for further information of the species to the *Transactions of the N. Y. State Agricultural Society* for 1854, p. 72.

1860. The Hunter Weevil. (The Country Gentleman, June 14, 1860, xv, p. 384 — 8 cm.)

Identification of the species (*Sphenophorus venatus* Say), from Onondaga county, N. Y., and pronounced identical with the "bill-bug or the corn-bug," of the Patent Office Report for 1854.

1860. Ravages of Insects on Forest and Fruit Trees — Remedy. (Journal N. Y. State Agricultural Society, for July, 1860, xi, No. 3, pp. 21, 22 — 22 cm.)

In a letter to Hon. B. P. Johnson, Dr. Fitch remarks upon a species of scale-insect depredating upon the trees in the parks and gardens in Albany, giving its natural history, and suggesting oil or grease as the best remedy to be used against it. He compares it with the *Lecanium aceris* of Europe, and as it seems to differ from that species, he had given it in his manuscripts the name of *Lecanium acericorticis*, or the maple-bark scale-insect. [Is *Pulvinaria innumerabilis* (Rathvon).]

1860. The Entomologist. No. XXIII. — The Striped Flea-beetle. (The Country Gentleman, July 12, 1860, xvi, p. 36 —40 cm.)

Insects sent from Solsville, Madison county, N. Y., as attacking beans under ground, when well-sprouted and within a half-inch of the surface, boring minute holes on the inner side of each half of the bean stunting it and causing it to turn black — are recognized as the striped flea-beetle, *Haltica* (*Phyllotreta*) *striolata* of Illiger. Its favorite food is mustard, but it is very fond of young cabbage plants, the cultivation of which it sometimes arrests in the vicinity of New York. Its underground habit of feeding seems to be unusual to it. The insect is described and its somewhat confused synonymy given. Dusting with lime, ashes, soot, etc., is recommended for arresting its ravages, as also, frequently driving them from the plants, as they are timid insects.

1860. The Entomologist. No. XXIV. — The Pear-blight Beetle. (The Country Gentleman, November 8, 1860, xvi, p. 302 — 44 cm.)

The insect is sent from Southampton county, Pa., as having destroyed a number of apple-trees. It attacks also the plum and apricot. It is the *Scolytus pyri* of Professor Peck [now known as *Xyleborus pyri*], and a description is given of it, with a statement of its habits. In the middle of summer, twigs are seen to wither. On examination, a small perforation like a pin-hole may be seen at several of the buds, upon

the bark. From these the burrows proceed, extending upward into the pith. The beetle also infests the trunks of trees, probably in its first brood. The remedy for the twig-blight is found in cutting off the blighted twigs as soon as observed, and burning them. For the attack upon the trunk, no remedy is known.

1861. The Entomologist. No. XXV.—The Quince Tingis. (The Country Gentleman, February 14, 1861, xvii, p. 25—45 cm.)

Insects sent from Leominster, Mass., with account of serious injuries to quince trees for the past three years, from July until late in the autumn. The eggs are laid and the insects work on the underside of the leaves, causing them to color and shrivel as if scorched by fire. The general appearance of the *Tingidæ* of the Hemiptera, to which the insect belongs, is described, looking like little drops of dried froth made up of numerous air-bubbles. This species is similar to *Tingis pyri*, of Europe, and is almost identical with *Tingis arcuata* of Say. Dr. Fitch had described a form found on butternut leaves as *T. juglandis*, but he has since come to the conclusion that it is but a straight wing-margined form of *T. arcuata*. The quince form is described and figured, and compared with *T. arcuata*, and is named *Tingis cydoniæ*. Its young form is also described. No remedy is known for its injuries. For destruction of noxious insects, the Hydropult, made by the American Hydropult Co. of New York, is highly recommended. By means of this, a number of alkaline washes and bitter infusions may be conveniently showered, and often with great success. [No notice of this species appears in Dr. Fitch's Annual Reports.]

1861. The Entomologist. No. XXVI.—The Wheat-Midge. (The Country Gentleman, April 1, 1861, xvii, p. 226—39 cm.)

For about thirty years, the midge has existed in the State of New York, as a formidable wheat pest. Last summer it was remarkably diminished or wholly extinct. Two species occur together in our wheat fields, the *C. tritici* and *C. cerealis* of similar habits, but the last is much the more rare. The habits and transformations are given. The *C. tritici* may be readily recognized when it enters our windows attracted by lights on warm and sultry evenings in June, by the bright yellow color of its body unlike any other minute fly that occurs in the same situation. They usually appear in the wheat-fields in New York, about the 15th of June. A guide for looking for them in other localities would be, at the time when the first solitary fire-flies are seen abroad, and when the white flowers of the locust-trees commence to fade and drop to the ground.

1861. The Entomologist. No. XXVII.—Disappearance of the Wheat-Midge. (The Country Gentleman, May 2, 1861, xvii, p. 290 — 36 cm.)

In 1859, the wheat in Central New York was reported as not injured by the midge. The following year, the insects were abundant about lamps in Washington county (Eastern New York), during the middle of June, but in July, no larvæ could be found in wheat-heads in a circuit of several miles. The same exemption from attack was found

upon examination in the wheat in adjoining counties in Vermont. In Canada West, the wheat was also uninjured the preceding year. In Western New York, the insect continues to be as common as heretofore. It appears then, that over a large extent of country, its injuries have greatly diminished, and in some places entirely ceased. Wheat may again be sown with every prospect of abundant return. The midge may again increase and become as great a pest as before, yet it seems more probable that its greatest injuries have passed, and that they will never again be repeated to the same extent, in this country.

1861. The Entomologist. No. XXVIII.—The Apple-tree Borer. (The Country Gentleman, June 6, 1861, xvii, p. 370—18 cm.)

In reply to inquiries made from Kansas of a borer injuring the young limbs of apple-trees in the manner detailed, the insect is identified as the *Bostrichus bicaudatus* of Say [now known as *Amphicerus bicaudatus*]. A description is given of it, and it is represented as common in the orchards of Michigan and Illinois, ranging from Pennsylvania to Mississippi, but not known to occur in New York or New England. Directions are given how to discover its attack, and for destroying it by cutting off and burning the infested twigs, or, when it enters at a fork of the limbs as stated in the inquiry, by thrusting in a wire until the beetle is reached and killed.

1861. The Army-Worm and Cut-Worm. (The Country Gentleman, July 4, 1861, xviii, p. 18—20 cm.)

The Cut-worms that sever the young cabbages, leaves, etc., so well known to all gardeners, are the progeny of the dark-colored "millers" that enter our houses on summer evenings, of which there are many species belonging to the genus *Agrostis* [*Agrotis*], of the *Noctuidæ*.

The Army-worm Dr. Fitch supposes to be "one of our common cut-worms multiplied to excess and having become gregarious and migratory like the locust." Specimens of the worms had been sent from Illinois which resembled the cut-worm except in its brighter colors, the result perhaps of its greater exposure to light. The moths had been received from Maryland, but in too poor a condition for identification, and its species was therefore at the present unknown. The "black worm" which had been so remarkably destructive over large districts, at intervals, in New England (several instances cited), are believed to have been traveling swarms of one of our common cut-worms.

1861. The Entomologist. No. XXIX.—The Army-Worm Moth. (The Country Gentleman, July 25, 1861, xviii, p. 66—49 cm.)

Dr. Fitch tells the story of his specific identification of the army-worm moth, which is of sufficient interest to justify its quotation. A specimen of the army-worm and the moth bred from it, had been sent to him from a correspondent in Illinois, in a tin tube of alcohol, the moth proving when extracted to be "a soft, shapeless black mass. On carefully disentangling and spreading its wings, and drying it, my first step was to compare it with the broken and effaced specimens received last year from Maryland. I hereupon saw that the Army-worm in Maryland last year and that now in Illinois were undoubtedly one

and the same insect. And now, by a searching look from one to the other of these soiled and imperfect specimens, I was able to gather from them certain marks by which I thought I could recognize this insect if I chanced to have any other specimens of it in my collections. Upon looking over the moths of the cut-worms, I find nothing like this among them. Turning then to another group, lo, here I have it! — two perfect specimens received a few years since in a fine collection from Professor D. S. Sheldon of Iowa College. *Laus Dei!* The riddle is now read. What for nearly a score of years I have been so anxious to obtain, I now have! I know what the moth of this Army-worm now is! And in the fulness of my joy hereupon, I thank you, Prof. Sheldon, and you Dr. Bartlett, and Dr. Jenkins, each and all, that you have collectively furnished me with such clues as have enabled me to make this discovery."

The above is followed by the history of the species — its naming by Haworth and renaming by Guenée, as given in the New York Reports (6th–9th, pp. 123, 124), and a description of the moth, as reproduced in p. 125, *loc. cit.*

1861. The Hunter Weevil. (The Country Gentleman, August 1, 1861, xviii, p. 80 — 7 cm.)

Identification of the species sent from Skaneateles, N. Y., together with statement of its ravages.

1861. The Grain Aphis. (The Country Gentleman, August 8, 1861, xviii, p. 96 — 11 cm.)

Numerous examples of the insect from various parts of New York, Connecticut and Massachusetts had been received for name, at the office of the Country Gentleman, in reply to which a letter of Dr. Fitch to Mr. B. P. Johnson, is published.

The insect is identified as *Aphis avenæ* Fabr., or *Aphis granaria* of Kirby and Curtis. Early in the season it attacks wheat, rye and barley, and as these grains harden, it deserts them for the oats, which it injures more severely. Its manner of attack is noticed. Various species of Ichneumon flies, Syrphus flies, and Lady-bugs have attacked it strongly, and will probably subdue it. Chloride of lime dusted over the plants might disengage a gas which would destroy them, and experiment with it is asked for.

1861. The Entomologist. No. XXX. — The Grain Aphis. (The Country Gentleman, August 15, 1861, xviii, p. 114 — 74 cm.)

First became numerous a year ago — observations upon it the present season — its identification as *Aphis avenæ* of Fabr., *A. granaria* of Kirby and Curtis — its habits — a parasitic attack upon it, and other insect enemies,— all of which is reproduced, with additional matter, in the Fitch Reports, 6th–9th, pp. 91–100. Following the above, is a note upon the wheat-midge, representing it as again injurious in Washington county, although no larvæ were to be found in the wheat the preceding year, whence it appears that the insect has some other place in which to breed; recommends the importation of its natural parasites.

1861. The Grain Aphis. (The New York Observer, of October 17, 1861.)

Referred to in Dr. Fitch's *6th–9th Repts. Ins. N. Y.*, p. 91, but has not been seen by me.

1861. Snapping Beetle — Blight on Apple-Trees. (The Country Gentleman, August 22, 1861, xviii, p. 130 — 15 cm.)

A correspondent from Plattsburg, N. Y., whose trees are dying from the scaling off of the bark, sends a beetle supposed to occasion the trouble.

The beetle proves to be one of the *Elateridæ* — species unknown. The injury results from some other cause, perhaps is of the same nature as the "fire-blight" of the pear-tree.

1861. An Important Caution. (The Country Gentleman, September 5, 1861, xviii, p. 161 — 11 cm.)

Where a grain-field has been infested with the Grain aphis, no animal should be pastured on the stubble of that field for three weeks after the harvest. The Lady-bugs which have gathered there to feed upon the aphis secrete a yellow acid juice from their joints, which is believed to be poisonous to animals eating many of the beetles. Some hogs having been turned into an oat-field the third day after its cutting, one became enormously swollen and died about noon, and others of them were seriously affected. A span of horses also became swollen upon being turned into an oat-field.

1862. Insects the past Year [1861]. (Transactions N. Y. State Agricultural Society, for 1861, xxi, 1862, pp. 27–31.)

Brief notice of insects studied during the year, viz., Grain-aphis, Army-worm and Wheat-midge. Remarks upon the great fecundity of the Aphis, the descendents of a single individual in twenty days amounting to upwards of two millions. The Army-worm determined for the first time. Number of parasites upon the Wheat-midge in Europe.

1862. The Entomologist. Entomological Events of the past Year. (Country Gentleman, for February 20, 1862, xix, p. 124 — 54 cm.)

Read as a letter, at the winter meeting of the N. Y. State Agricultural Society, in February, 1862. Gives the observations and studies of Dr. Fitch during the preceding year, upon the Grain Aphis, the Army-worm and the Wheat-midge.

1862. The Entomologist. No. XXXI. — Insect Tumors and Wounds in Raspberry Stalks. (Country Gentleman, for May 22, 1862, xix, p. 335 — 52 cm.)

Infested galls upon wild raspberry, *Rubus strigosus*, from Lockport, N. Y., and identical ones upon the Antwerp variety of raspberry, *Rubus Idæus*, from Poughkeepsie, N. Y., gave some gall insects which were apparently an undescribed species of the family *Cyniphidæ* and of the

genus *Figites*. They are accordingly named *Figites rubus-caulis*, or the raspberry-stalk gall-bee. The insect and its habits are described, together with its gall.

Some raspberry canes were received, showing a row of small holes bored into them for the reception of small, shining white eggs, causing the canes to crack open and show the pith. Dr. Fitch had seen the same in wild raspberry, also in willow, and in cherry. In 1858, the apple-twigs in some orchards in Akron, O., were extensively injured in the same manner. Watch was set for the depredator — it was caught in the act — sent to Dr. F., and by him identified as the Buffalo tree-hopper, *Ceresa bubalus* Fabr.

[Professor Riley, in his *Fifth Report on the Insects of Missouri*, p. 121, states that the above punctures are the work of another insect, viz., the Snowy cricket, *Œcanthus niveus* Harris. The punctures made by *C. bubalus* are different, as figured (*loc. cit.*, fig. 50) and described.]

1862. The Buffalo Tree-Hopper. (The American Agriculturist, for June, 1862, xxi, p. 172.)

Communicates a portion of the matter relating to this insect contained in the 12th Report on the Insects of N. Y. (*Trans. N. Y. St. Agricultural Society*, xxvii, 1867, pp. 889–893).

1862. The Entomologist. No. XXXII. — The Asparagus Beetle. (The Country Gentleman, for July 31, 1862, xx, pp. 81, 82 — 73 cm.)

The Asparagus plant grows wild in Europe, Africa and the West Indies. Since first introduced in this country, perhaps two hundred years ago, it has been exempt from the insects that attack it in Europe, until the present time, when its principal European pest, the *Crioceris asparagi*, has been discovered in Queens county, on Long Island. The beetle and its larva are described and figures presented of them. In considering the means of combatting the insect, the fact is stated that the long experience with it in Europe had given no better method than that of hand-picking; it is therefore probable that the same method will have to be employed here. This need not be regarded as an irksome and endless task — it may become a pleasant pastime. It is believed to be possible to exterminate it, by diligently collecting it by hand from the few plants that it may be necessary to grow, and cutting down all others during two or three months, commencing early in June. An organized effort for its prompt extermination through Horticultural and Agricultural Societies, and the appointment of efficient town committees, is recommended

1862. The Entomologist. No. XXXIII.— The Maple Psocus. (The Country Gentleman, September 4, 1862, xx, p. 162 — 35 cm.)

Insects received from Prospect Hill, N. Y., where on August 11th, they were infesting fruit and ornamental trees. Their first appearance, in a wingless state, was about the 1st of August; later (when sent) they were winged. They were said to be remarkably timid creatures.

occurring on the shady side of the branches, from which they sucked the sap.

The same species had been observed by Dr. Fitch, July 29, 1854, on maple, and on the shad-bush (*Amelanchier botryapium*) [*A. Canadensis* var. *botryapium*]. It belongs to the *Psocidæ*, of which the "book-louse" is a familiar example — called also, "dust-louse," from its being at times found abundantly in the sweepings of neglected chambers, — known from its clicking call to its mate, as the death-watch [is *Clothilla pulsatoria*]. It eats dried plants and insects — is readily destroyed by camphor.

The Maple Psocus is the largest of our species. Dr. Fitch had previously given it the MS. name of *Psocus aceris*, and it is now described. [It is the *Psocus venosus* of Burmeister: see Hagen's *Neuroptera of North America*, 1861, p. 10.]

1863. A brief account | of the most important | Injurious Insects | of the | United States | — | By Asa Fitch, M. D. | New York State Entomologist. | — | Albany: | Luther Tucker & Son, 395 Broadway. | 1863. | Pamph., 12 mo. pp. vi (including title-page, cover and index of subjects and illustrations) + 293–321, from the Illustrated Annual of Rural Affairs.

Contains general remarks upon insects, describes their several stages, gives their divisions into orders and mentions other groups. Among their economic divisions are noticed (often at considerable extent): I. Insects injurious to fruit-trees; of which are these: the curculio, apple-tree caterpillar, fall web-worm, apple-tree borer, peach-tree borer, and apple bark-louse. II. Insects injurious to grain crops; among which are the wheat-midge, Hessian-fly, four species of *Eurytoma*, chinch-bug, Angoumois moth (*Butalis cerealella*), grain-aphis (*Aphis avenæ* Fabr.), grain-weevil (*Calandra granaria* Linn.), and cut-worms. III. Insects injurious to gardens, as, the cucumber-bug, squash-bug, flea beetle, rose-bug, and asparagus beetle. The above insects are illustrated in thirty-four figures.

1863. Insects.—The Grain Aphis, Wheat Midge, etc. (Transactions N.Y. St. Agricultural Society, for 1862, xxii, 1863, pp. 32–38.)

An essay read by Dr. Fitch at the Rochester State Fair, evening meeting, October 1st, 1862.

The Grain Aphis has existed in Europe from time immemorial. It was named and described by Linnæus eighty-one years ago, as *Aphis avenæ*. European accounts of it are meager and imperfect, but its history had been completed by Dr. Fitch recently. Its sudden irruption last year in New York and New England was our first observation of it. This year it extended westward over Canada into Michigan. It had probably existed in this country in limited numbers for many years, having been observed on wheat seventeen years ago. No aphis had hitherto shown such a sudden excessive multiplication. During the last of June two great changes occur: the scattered individuals on leaves and stalks congregate on the heads, and change from grass-green to yellow.

This species is an exception to the ordinary generation of aphides, in that it deposits no egg in the autumn, but hibernates beneath the snow. No eggs have been observed, nor males — it apparently produces young indefinitely. The winged forms produce two young in a night — the wingless, four: these last bring forth young in three days. Various insects that prey upon them are noticed.

[The above (except the assembling and change of color) is additional to the account given in 6th–9th Repts. Insects N. Y., pp. 91–98.]

Remarks upon the Wheat-midge and other insects were made in a general discussion following the essay.

1863. Locust-Tree Borer. (Transactions N. Y. State Agricultural Society, for 1862, xxii, 1863, p. 88.)

Notices the occasional attack of the *Clytus robiniæ* [*Cyllene robiniæ*] upon the honey-locust, *Gleditschia triacanthus*, as well as upon the common locust; also, *Ctenucha Latreillana* [*C. Virginica* Charp.] as a rare species.

1863. The May-Beetle. Worm on Grape-Vines. (The Country Gentleman, for June 18, 1863, xxi, p. 399 — 13 cm.)

Identification of the May-beetle, *Lachnosterna fusca*, as injuring cherry-trees, after dark, at Bailey's Cross Roads, Va., occasionally stripping them, and also plum-trees, of all their leaves. Shaking upon sheets, killing with boiling water, and feeding to swine or poultry, recommended as the best remedies.

Spilosoma Virginica identified, as feeding on the young tender leaves at the extremity of the shoots of grape-vines, in West Haven, Conn. The insect is briefly described, and hand-picking recommended as the best remedy for it.

1863. A Grape-Vine Beetle and Rose Bug. (The Country Gentleman, for July 23, 1863, xxii, p. 65 — 20 cm.)

The Grape-vine flea-beetle, *Haltica chalybea* Ill. [*Graptodera chalybea*], attacks the eye or bud when it first begins to swell, in Cumberland, Md. It had been very abundant and injurious in the same manner, in different parts of New York, the past and present year.

The Rose-bug attacked the grape blossoms and continued to destroy the grapes until about half-grown. In Saratoga county they had destroyed the young plants of Indian corn, and stripped the leaves and fruit from grape-vines in some gardens at Saratoga Springs. For full account of this insect, reference is made to *Trans. N. Y. State Agricultural Society* for 1855, pp. 477–484, and for notices, *Country Gentleman*, 1856, viii, p. 75, and in August, 1859.

1864. Aphis on Apple-tree buds. (The Country Gentleman, for June 2, 1864, xxiii, p. 351 — 10 cm.)

Aphis mali received from Mr. J. J. Thomas, who finds the opening flower-buds of his apple-trees in the early part of May, thronged with the insects nestling close down among the pubescence. The insects are the young of the apple-tree aphis hatched from eggs which had been deposited late in the autumn in the crevices beneath the bark. They

hatch just as the buds begin to swell, when they crowd to them, where they are nourished until the leaves become sufficiently developed for their sustenance.

1864. The Hunter Weevil. (The Country Gentleman, for June 16, 1864, xxiii, p. 384 — 6 cm.)

Received from Dutchess county, N. Y., where they were drawing the juices from young corn beneath the ground. Identified as *Sphenophorus venatus* Say, and references made to previous notices in the *Country Gentleman.*

1864. The Entomologist. No. XXXIV.— The Buffalo Tree-hopper. (The Country Gentleman, for June 16, 1864, xxiii, p. 386 — 63 cm.)

Describes the punctures made in raspberry twigs and the eggs deposited in the pith, in straight rows of from one and a half to three inches long, which had been identified by Mr. Howe, of Akron, O., as made by the above-named insect, *Ceresa bubalus.*

A punctured twig, in part, in section, to show the eggs, is figured, together with the insect, which is described. The punctures in the raspberry twig may have been made by another species of *Ceresa* of similar habits," for it is only in the apple-tree that the *C. bubalus* has been actually seen in the act of depositing its eggs." About 100 similar punctures in two rows, of 3¼ and 1¼ inches each, probably the work of one insect, had been seen by Dr. Fitch in an elder-stalk. The oviposition of the insect is described, also the hatching of the eggs, and the young insects. Shaking the trees or shrubs that the insect infests, to drive it away, is recommended.

1864. The Five-marked Coccinella, destroying Plant-Lice. (The Country Gentleman, for July 21, 1864, xxiv, p. 47 — 19 cm.)

A gentleman writing from L'Original, C. W., states that upon a cherry-tree infested with plant-lice, he discovered numerous larger insects, which, in the belief that they were a greater pest, he endeavored to destroy by beating from the tree and killing, but their large number compelled him to abandon the task. The next day, on examining the trees again, he found that the plant-lice had nearly disappeared, and the other insect was busily feeding upon them. Two examples were sent to Dr. Fitch for determination. One had eaten the other when received, and the survivor, having undergone its transformation to the perfect state, proved to be *Coccinella 5-notata* of Kirby.

1864. The Entomologist. No. XXXV.— The Nebraska Bee-killer. (The Country Gentleman, for July 28, 1864, xxiv, p. 63 — 84 cm.)

Received from Otoe county, Nebraska, where it is " very destructive to the honey-bee, killing a great number of them, and also of the rose-bugs." It is briefly characterized as a dipterous insect of the genus *Trupanea* of Macquart, and as it differs from the half-dozen known United States species, it is named from its habits, *T. apivora* [now placed in the genus *Promachus*]. A minute description of the fly is

given, with mention of the habits of the *Asilidæ*, to which this fly belongs. The observation, upon a single occasion, ten years previous, in the month of October by Dr. Fitch, of *Erax rufibarbis* is narrated — never since met with by him. The piping noise of these flies, like that of the bumble-bee when inclosed in a net, is mentioned, and also, their fetid, carrion-like odor. After the four Nebraska specimens had "been dead a fortnight, and freely exposed to the air the latter half of the time, the disgusting scent still remained, and so powerful was it that on two occasions, nausea was produced" by their presence on a table. This odor may perhaps only attach to them at their period of sexual intercourse. [This notice is also published in the Eighth Report on the Insects of N. Y. (6th–9th Reports, 1865, pp. 251–255), together with additional observations upon the habits of the insect in destroying bees and other insects.]

1864. A Curious Insect. (The Country Gentleman, for August 5, 1864, xxiv, p. 79 — 20 cm.)

The two-spotted tree-hopper, *Enchenopa binotata*, received from Council Bluffs, Iowa, as infesting bittersweet. When confined in a glass vessel, it was said to spring against the sides with such violence as to break off its head [the tip of its thorax]. Dr. Fitch states that it is often found in New York on butternut and on dogwood.

1865. The Entomologist. No. XXXVI. — The Aphis on Hops. (The Country Gentleman, for April 27, 1865, xxv, p. 274 — 56 cm.)

This aphis was first observed in this country two years ago, and since its first detection, has been very destructive — at times destroying entire yards. Newspapers are mentioning three hop maladies, viz., the plant-louse, the honey-dew, and the black-blight, but these are but forms of the same thing. The connection of the last two with the aphis is shown. The insect proves to be the same as the long-known and destructive *Aphis humuli*, of Europe. The excessive number of plant-lice in some years is subdued by numerous predaceous and parasitic destroyers, which at the present time are very abundant. Soap applications will kill the young of the hop-louse. All can be killed by tobacco-smoke, which is unfailing. Perhaps it could be employed by confining it in a large cloth thrown over the vines.

1865. Plant Lice — The Hop-Aphis. (The Country Gentleman, for August 3, 1865, xxvi, p. 82 — 27 cm.)

In reply to inquiries of the winter retreat of this insect, it is stated: Most of the plant-lice, at the end of the season, become oviparous, and deposit their eggs under the loose bark or other shelters of the vegetation upon which they feed. If the hop-aphis oviposited upon the vines, the eggs would be killed when the vines are destroyed in the autumn. This point in its history has not been fully given by the English writers who have treated of it, during the many years that it has engaged their attention. In *Morton's Encyclopedia of Agriculture*, ii, 55, Dr. Plomley makes the statement, "as the result of his personal observation, that the hop-fly in May proceeds originally from *sloe bushes*.

He also positively asserts that the autumn generation deposit their eggs in sloe bushes, whence their progeny emerge into the hop grounds in the following season." This statement is corroborated by the fact, that from another species of wild plum, *Prunus mahaleb*, M. Fonscolomb described a new species of aphis, as *Aphis pruni-mahaleb*, which subsequent researches showed to be identical with the hop-aphis. Dr. Fitch is of the opinion, that after the death of the small and wingless lice with the death of the vines, the winged ones fly away to the nearest plum-trees, where they sustain themselves upon the leaves until they have deposited their eggs, destined, if not previously destroyed, to hatch the following spring.

1865. Entomological Correspondence. (The Country Gentleman, for September 21, 1865, xxvi, pp. 190, 191 — 70 cm.)

The Yellow-necked Apple-tree Worm, occurring in Lockport, N. Y., about the 1st of August, upon hundreds of young apple-trees, some of which they stripped of their leaves, is briefly described, together with the moth that it produces, viz., *Datana ministra* (Drury). Reference for a full account is made to *Trans. N. Y. State Agricultural Society* for 1855, p. 467. The best remedy is to sever the twig with the congregated caterpillars and drop them in a fire.

Locust Hispa. Received from Locust Bay, L. I. The beetle, *Anoplitis scutellaris* Olivier [now *Odontota scutellaris*], is briefly described and its natural history given. It is represented as very numerous at Glen Cove, where the trees ravaged by it look as if burned by fire. The insect has not been observed in the interior of the State.

Black Prickly Worms eating the Leaves of Canada Thistles are identified as *Cynthia cardui*. It is parasitized by *Banchus fugitivus* Say.* Some notes upon the butterfly are given. [For accounts of thistles and briars completely stripped by these caterpillars, see *Count. Gent.* of Sept. 7, 1865, p. 155, and id. for Oct. 5, 1865, p. 219.]

1865. Address delivered before the Annual Meeting of the State Agricultural Society, Albany, February 8, 1865. (Transactions N. Y. State Agricultural Society, for 1864, xxiv, 1865, pp. 111–116.)

Attack of the hop plant-louse, the previous year in New York; nature of the attack, producing "honey-dew" and "black-blight": the insect identified with the *Aphis humuli*, of Europe; its enemies; remedies considered; soap-suds not reliable; tobacco-smoke recommended.

1866. Joint-Worm in Wheat on Long Island. (The Country Gentleman, for July 19, 1866, xxviii, p. 49 — 20 cm.)

The larvæ reported as infesting the joints of wheat at Glen Cove, L. I., are probably the joint-worm, *Eurytoma tritici*, noticed in the *Cultivator*, October, 1851, viii, p. 322, and in *Trans. N. Y. St. Agr. Soc.* for 1861, pp. 830–841. As they are chiefly lodged at the lower joint, if the wheat is cut above this point, the stubble may be turned under, burying the insects while in their larval state so deeply that they will be destroyed.

**Limneria fugitiva* (Say). For other Lepidoptera (six species of moths) upon which it is parasitic, see *Fourth Report on the Insects of Missouri*, 1872, p. 41.

1866. Beetle on the Grape. (The Country Gentleman, for August 30, 1866, xxviii, p. 142 — 11 cm.)

The Brown Colaspis, *Colaspis brunnea* Fabr., received from Walpole, Mass., destroying grapevines, July 21. Dr. Fitch had frequently collected it from the wild grapevine, the cinquefoil or *Potentilla*, and some other plants, but not from the cultivated grape before the present year. Dusting with ashes, soot, or some other powder, should prevent its ravages.

1866. Insects which Injure Grain Crops.— I. The Wheat-Midge. (The Country Gentleman, for November 8, 1866, xxviii, p. 306 — 68 cm.)

Gives an account of *Cecidomyia tritici*, and refers to *C. graminis* Fitch and *C. inimica* Fitch, which are treated of more fully in the first 90 pages of the *Sixth Report on Noxious Insects*. Eight figures are given in illustration, similar to those of the Report cited.

1866. Insects which Injure Grain Crops.— II. The Hessian Fly. (The Country Gentleman, for November 29, 1866, xxviii, p. 354 — 60 cm.)

Gives an account of the Hessian fly, *Cecidomyia destructor* Say, illustrated with figures of the fly, diseased and healthy wheat-plants, the larva and pupa, lower joint of a diseased wheat straw, and one with sheath torn off showing the worms. Notices also two parasites upon the Hessian fly, viz., *Semiotellus destructor* of Say, and another observed by Mr. Herrick, of Yale College, inserting four or five of its eggs in a single egg of the Hessian fly. This species Dr. Fitch proposes to designate as *Platygaster Herrickii*. [Prof. Cook has observed a similar egg-parasite of the Hessian fly (perhaps the same as the above), which Dr. Packard refers, with doubt, to *Platygaster error* Fitch (*Bull. No.* 4, *U. S. Entomolog. Commis* , 1880, p. 21, f. 1).]

1866. Ants Enemies to Cut-Worms. (Transactions N. Y. State Agricultural Society, for 1865, xxv, 1866, p. 133.)

Reply to letter of W. C. Watson, narrating an attack of a black ant upon a cut-worm. Similar attacks observed by Dr. Fitch and explanation offered ; also, injuries of the little yellow ant (*Myrmica molesta*) to corn and other vegetation.

1867. Currant Borers. (The Country Gentleman, for June 13, 1867, xxix, p. 386 — 14 cm.)

Brief notice of the operations of the American currant-borer, *Psenocerus supernotatus* (Say), in the pith of a currant stalk, and reference for figure and a full account of it, to the 3d Report on the Noxious Insects of the State, in *Trans. N. Y. State Agr. Soc.* for 1856, pp. 416–423.

1868. Excrescences upon Grape Leaves. (The Country Gentleman, for August 20, 1868, xxxii, p. 127 — 41 cm.)

Treats of four grape-leaf galls that had come under observation. The first had been described in *Trans. N. Y. State Agr. Soc.* for 1854, p. 41

862, as *Pemphigus vitifoliæ*. The second, not named, were rough water-like galls, size of musket shot of different sizes, upon the under side of leaves, in July and August, opening upon the upper side, and occupied by small oval lice of a dull yellow color. The third, observed the middle of August, smooth, succulent, greenish-yellow, size of large and small musket shot, growing in the leaf, and bulging out equally on both sides, having no opening, but an internal cavity in which no insect could at the time be perceived. It occurred on the wild grape, *Vitis labrusca*. The fourth had not previously been seen, and was probably new. They were thorn-like, growing on the under side of the leaves in July, straw-colored, of a regular conical form, projecting outward at a right angle from the surface, which they covered entirely; four times as long as thick, from three to four-tenths of an inch long, of a dry, firm texture, and fluted or ribbed lengthwise. Opposite their base, on the upper side of the leaf was a small pit. They contained a small yellow maggot, the description of which is given, and which is apparently a species of *Cecidomyia*.

1869. A Curious Water Insect. (The Country Gentleman, for February 25, 1869, xxxiii, p. 154 — 23 cm.)

The larva of the insect captured from under ice a foot thick, identified as *Æschna heros* Fabr., with larval description and habits.

1869. Garden Insects. (Illustrated Annual Register of Rural Affairs, 1869, v, pp. 91–104, figs. 1–16.)

Notices, among others, the following insects: The onion-fly (*Anthomyia ceparum*), pp. 91–96; the striped blister-beetle (*Cantharis vittata*); the radish and cabbage flies (*Anthomyia raphani* and *A. brassicæ*); centipedes, cut-worms, and the flea-beetles; the garden flea (*Smynthurus hortensis*); the cabbage-moth (*Cerostoma brassicella*) [is *Plutella cruciferarum* of Zeller], and the cabbage butterfly (*Pieris oleracea*).

1869. Garden Insects. 2d Article. (Ib., pp. 197–212, figs. 1–22.)

Notices additional garden pests, of which the principal are the following: The cabbage aphis, pp. 198, 199; the cucumber beetle, pp. 200, 201; the squash-bug; squash Coccinella (*C. borealis*); the asparagus beetle, pp. 204, 205; the tomato-worm (*S. quinquemaculata*), pp. 205, 206; the Southern tobacco-worm (*S. Carolina*); the 10-lined potato-beetle (*Doryphora 10-lineata*), pp. 207, 208; the 3-lined potato-beetle (*Crioceris trilineata*); the striped blistering-fly, and wire-worms, pp. 210, 211.

Notice of the Entomological Labors of Dr. Fitch.

The following notice of the labors and writings of Dr. Fitch is extracted from a "Report on some Injurious Insects of the Year 1879," presented by me to the State Agricultural Society at its Annual Meeting, January 21, 1880.

It seems eminently fitting that in connection with the preceding notes upon the economic relations of some of our insects, reference should be made to one

who labored long and successfully in the department of Economic Entomology — whose contributions therein gave him an exalted name among entomologists, and to whose enthusiastic, long-continued and valuable labors that branch of natural science is largely indebted for the honorable position it now holds in our country.

Dr. Asa Fitch died at his residence at Salem, Washington county, N. Y., on the 8th of April 1879, at the age of 70 years. His entomological studies commenced about the year 1840, at which time he prescribed for himself such an admirable plan for the direction of his future labors in the field of Entomology, that we will be pardoned for quoting it at length. He wrote thus: —

"I have undertaken a very great work, and have laid for myself a task both hard in the plan and difficult in the execution. To unite in one very limited body the most essential facts of the history of insects; to class them with precision and accuracy in a natural series; to delineate the chief traits in their physiognomy; to trace in a laconic and strict manner their distinctive characters, and follow a course which shall correspond with the progress of the science and the eminent men who have contributed to its advancement; to single out the useful and obnoxious species, those which from their manner of living excite our curiosity; to mark the thousand sources where the authors of the original knowledge may be consulted; to render to Entomology that amiable simplicity which she has had in the times of Linnæus, of Geoffrey, and of the first productions of Fabricius, and yet present her as she is to-day, with all the richness which she has acquired from observation, but without surcharging her with it; to conform her, in one word, to the model which I have under my eyes, the work of Cuvier — such is the end which I have taken upon myself to attain."

During the years 1845 to 1851, Dr. Fitch contributed a series of valuable papers on *Winter Insects* and others, to Emmons' *Quarterly Journal of Agriculture and Science.* In 1850, he prepared a descriptive catalogue of the United States insects of the suborder of Homoptera, which was published the following year in the *Fourth Annual Report of the N. Y. State Cabinet of Natural History.* These now scarcely accessible papers richly merit republication.

In the year 1854, his connection with this Society was commenced, in his selection by the Executive Committee of the Society to examine and report upon the Noxious, Beneficial, and other Insects of the State of New York, under an appropriation by the Legislature for that purpose. His first Report was presented under date of March 14, 1855. Under the continuation of the annual appropriations for the purpose, subsequent Reports were annually presented with the exception of three intervals of a year each — to the number of fourteen — the last one published in the Transactions of the Society for the year 1870. In 1872, by an act of the Legislature, the office of State Entomologist was abolished — the impaired health of Dr. Fitch not permitting him longer to discharge the duties of the position.

The series of the Fitch Reports is regarded by entomologists, and others who are prepared to appreciate their merit, as very valuable contributions to science. They are characterized by an untiring zeal, minuteness of observation, fulness of detail, faithfulness of delineation and dignity of expression. They consist largely of the results of original research; and so highly were these researches

estimated abroad, that he was elected to membership in the Entomological Societies of France and of Russia, and a gold medal was bestowed upon him by the Central Agricultural Society of France, in appreciation of his services to science.[*] Among his foreign correspondents he numbered Westwood and Curtis of London, Andrew Murray of Edinburgh, Dr. Gerstacker of Berlin, Dr. Signoret and M. Selys de Longchamps of Paris, and many others of the most eminent entomologists of Europe.

It may properly be claimed that the New York Reports led the way for similar investigations in other States of the Union, and to the interest which they aroused, we are indebted for the valuable series of Riley's Reports on the Insects of Missouri — nine in number, and comprising over 1,800 pages and numerous illustrations of a high order,— the Reports of the State Entomologists of Illinois, and others.

[*The medal was awarded to Dr. Fitch, in the year 1858, after the publication of his First and Second Reports, in consideration of their value to Agriculture. The following description of the medal and translation of the Report accompanying it, is extracted from the New York State Agricultural Society's Transactions for the year 1858:

The medal weighs an ounce, nearly — bears on the obverse side the portrait of the *Father of French Agriculture*, surrounded with the inscription, "Olivier de Serres, N. en 1539, M. 2, jt 1619;" on the reverse an agricultural wreath, around which are the words, "Societe Imperiale et Centrale d'Agriculture;" and on its inside, "A Mr. Asa Fitch, a Albany, State of New York, 1858."

The following is the Report:

[Translation.]

Imperial Central Society of Agriculture, Paris — Report.

The Society has lately received, through Mr. Vattemare, an important work, by Mr. Asa Fitch, of the State of New York, on Insects which are injurious in Agriculture, and it has charged the section of Natural History to make a report to the Society upon it.

The work is composed of two reports, addressed to the Agricultural Society of New York, and published by the Legislative Assembly of the State. It treats principally of the insects which attack fruit trees, and contains a large number of observations, accurately made, relative to the habits of these animals, and also very judicious application of these facts to the treatment of plants infested by them. On account of the peculiarity of these investigations, which embrace a multitude of minute and often isolated details, it would be difficult in this report to present an analysis of the work of Mr. Fitch, but we believe it to be our duty to recommend it to the attention of Naturalists, who are engaged in the study of the relations of Entomology to Agriculture. The larger part of the facts mentioned by the author belongs to the history of varieties which are only found in America, and consequently do not directly interest French Agriculture; still there will be found many observations from which Entomologists of every country will be able to profit, and we think that it is the duty of the Imperial Central Society of Agriculture to encourage all good works undertaken in such a useful direction.

The section has the honor, therefore, to propose to the Society to award to Mr. Asa Fitch a Gold Medal, with the bust of Olivier de Serres, in acknowledgment of his work.

[Signed] A. VALENCIENNES,
GUERIN MENEVILLE,
MILNE EDWARDS,
Committee.

The resolution proposed was adopted at the meeting of April 14, 1858. A true copy.

Signed: For the Permanent Secretary:
The Recording Secretary, F. De Lagarde.]

The labors of Dr. Fitch will long be held in grateful remembrance, and the New York State Agricultural Society may justly lay claim to having, by its action in connection therewith, done very much toward the promotion of Entomological research, not only within the immediate sphere of its labors, but throughout the Union, and to science at large — coextensive with the civilized world.

(B.)

INSECT DEPREDATORS UPON THE APPLE-TREE.

The following are all the United States species (one hundred and seventy-six in number) that are known to me, or have been reported upon accepted authority, as depredating upon the Apple-tree. The list will, without doubt, be largely extended ; it is published at this time to serve as the basis for future additions. An entire exploration of our entomological literature might add nearly or quite fifty species, and careful observation would unquestionably give us no inconsiderable number which have not yet been recognized as apple insects.

It is hardly necessary to state that not all the species here recorded are to be included among those injurious to the apple-tree, but as each one is known to make it, at times, its food-plant from choice (many others will feed upon it in confinement),* the least harmful among them may at any time, through such sudden and inexplicable multiplication as is often witnessed in the insect world, become seriously injurious.

The authority for including the species in the list is given in each instance. For the convenience of those who may be willing to scrutinize the list with a view of supplying omissions, the species have been grouped under their several orders, and for the most part, in their latest systematic arrangement.

Lepidoptera.

Diurnals.

Papilio Turnus Linn.	*Turnus swallow-tail*	Harris, Ins. Inj. Veg., 268.
Limenitis disippus Godt.	*Disippus butterfly*	Scudd., Bul. Buff. Soc., ii, 250.
Limenitis ursula (Fabr.).	*Ursula butterfly*	Riley, Amer. Ent., ii, 276.
Thecla strigosa Harris.	*Streaked Thecla*	Scudd., Bul. Buff. Soc., iii, 111.

Sphingidæ.

Deilephila lineata (Fabr.).	*White-lined Sphinx*	Riley, Amer. Ent., i, 206.
Smerinthus excæcatus (Sm.-Abb.).	*Blind-eyed Sphinx*	Harris, Ins. Inj. Veg., 327.
Sphinx drupiferarum (Sm.-Abb.).	*Plum Sphinx*	Lintner, Proc. E. S. Ph., iii, 658.
Sphinx Gordius Cram.	*Apple Sphinx*	Harris, Ins. Inj. Veg., 328.

*Mr. R. Thaxter has found that nearly all of the *Scopelosomes* larvæ, and many others of Noctuid genera, will eat the leaves.

Bombycidæ.

Spilosoma Virginica (Fabr.). *Virginia ermine-moth*..... Walsh, Pract. Ent., ii, 103.
Hyphantria textor Harris. *The Weaver* .... Fitch, N. Y. Rept., iii, 19.
Halisidota caryæ (Harris). *Hickory tussock-moth*..... Id., ib., 19.
Halisidota maculata (Harris). *Spotted tussock-moth*..... Thaxter, *in lit.*
Orgyia leucostigma (Sm.-Abb.) *White-marked tussock-moth.* Harris, Ins. Inj. Veg., 366.
Parorgyia parallela Gr.-Rob..... Coquillet, Ill. Rept., x, 166.
Lagoa opercularis (Sm.-Abb.)..... Walsh, Amer. Ent., ii, 29.
Euclea querceti Her.-Sch..... Thaxter, *in lit.*
Parasa chloris (Her.-Sch.). *Green hag-moth*..... Riley, Amer. Ent., ii, 307.
Empretia stimulea Clem. *Saddle-back caterpillar*..... Id., ib., i, 40.
Phobetron pithecium (Sm.-Abb.). *Hag-moth*..... Id., ib., ii, 340.
Limacodes scapha Harris. *Skiff Limacodes* ..... Thaxter, *in lit.*
Lithacodes fasciola Her.-Sch. *Banded Lithacodes*..... Id. ib.
Thyridopteryx ephemeræformis (Haw.). *Bag-worm* .... Riley, Amer. Ent., ii, 38.
Datana ministra (Drury). *Yellow-necked apple-tree worm.* Fitch, N. Y. Repts., i-ii, 235.
Datana integerrima Gr.-Rob..... Gr.-Rob., Proc. E. S. Ph., vi, 12.
Œdemasia concinna (S.-A.). *Red-humped ap-tr. caterpillar* Harris, Ins. Inj. Veg., 425.
Œdemasia eximia Grote..... Thaxter, *in lit.*
Cœlodasys unicornis (Sm.-Abb.). *Unicorn prominent*... Harris, Ins. Inj. Veg., 424.
Callosamia Promethea (Linn.). *Promethea moth*..... Minot, Canad. Ent., ii. 100.
Samia Cecropia (Linn.). *Cecropia Emperor moth*..... Harris, Ins. Inj. Veg., 388.
Hemileuca Maia (Drury). *Maia moth*..... Marten, Ill. Rept. x, 128.
Hyperchiria Io (Fabr.). *Io Emperor moth*..... Saunders, Ins. Inj. Fr., 139.
Clisiocampa Americana Harr. *Apple-tree tent-caterpillar.* Harris, Ins. Inj. Veg., 373.
Clisiocampa sylvatica Harr. *Forest tent-caterpillar*..... Id., ib., 375.
Clisiocampa sp.? (*An Oregon apple-tree caterpillar*)..... Stretch, Papilio, iii, 19.
Clisiocampa sp.? (*Associated with prec.*)..... Id., ib., 20.
Gastropacha Americana Harr. *American lappet-moth*... Harris, Ins. Inj. Veg., 377.
Tolype velleda (Stoll). *Velleda lappet-moth* ..... Id., ib., 379.

Noctuidæ.

Acronycta occidentalis Gr.-Rob..... Lintner, Ent. Contrib., i, 62.
Acronycta morula Gr.-Rob..... Id., ib., ii, 137.
Acronycta luteicoma Gr.-Rob..... Thaxter, Papilio, iii, 17.
Acronycta Radcliffei Harvey..... Id., ib.
Acronycta clarescens Guen..... Id., ib.
Agrotis clandestina Harr. *W-marked cut-worm* ..... Riley, Mo. Rept., i, 79.
Agrotis messoria Harr. *Dark-sided cut-worm*..... Id., ib., 74.
Agrotis Cochranii Riley.* *Cochran's cut-worm* ... . Id., ib., 74.
Agrotis scandens Riley. *Climbing cut-worm*..... Id., ib., 76.
Agrotis saucia (Hubn.). *Variegated cut-worm*..... Id., ib., 72.
Mamestra assimilis Morr..... Thaxter, *in lit.*
Laphygma frugiperda Guen. *Fall army-worm*..... Riley, Amer. Ent., ii, 364.
Amphipyra pyramidoides Guen. *Pyramidal grape-vine cat.* Guenée, Noct., iii, 398.
Orthosia instabilis Schiff. *Unstable drab-moth*..... Fitch, N. Y. Rept., iii, 25.
Xylina Bethunei Gr.-Rob. *Bethune's Xylina*..... Thaxter, *in lit.*
Xylina antennata Walk. *Ash-grey pinion*..... Riley, Mo. Rept., iii, 135.
Nolophana malana (Fitch). *Shoulder-striped Tortrix*.... Fitch, N. Y. Repts., i-ii, 241.
Aletia argillacea Hubn. *Cotton-moth*..... Amer. Entomol., iii, 68.
Catocala grynea Cramer..... Coquillet, Ill. Rept., x, 184.

*Now regarded by Riley, as identical with *A. messoria.*

Geometridæ.

Ennomos subsignaria Hubn. *Snow-white linden-moth**..	Dodge, Canad. Ent., xiv, 30.
Eurymene Keutzingaria Grote.....	Thaxter, *in lit.*
Corycia vestaliata Guen. *Vestal Corycia*.....	Perkins, Prof. G. H., *in lit.*
Hybernia tiliaria Harr. *Lime-tree winter-moth*.....	Harris, Ins. Inj. Veg., 472.
Phigalia? cinctaria French. *Banded Phigalia*.....	French, Ill. Rept., vii, 241.
Anisopteryx vernata Peck. *Spring canker-worm*.....	Harris, Ins. Inj. Veg., 463.
Anisopteryx pometaria Harr. *Autumn canker-worm*....	Id., ib., 463.

Tortricidæ.

Teras Cinderella (Riley). *Green apple-leaf-tyer*.....	Riley, Mo. Rept., iv, 46.
Teras malivorana (Le Baron). *Lesser apple-leaf folder*..	Le Baron, Ill. Rept., i, 20.
Cacœcia rosaceana (Harr.). *Oblique-banded leaf-roller*..	Harris, Ins. Inj. Veg., 480.
Cacœcia argyrospila (Walk.).....	Riley, Trans. Am. E. S., x, 12.
Lophoderus triferana (Walk.).....	Murtfeldt, ib., 15.
Eccopsis malana Fernald. *Apple-bud worm*.....	Coquillet, ib., 72.
Eccopsis permundana (Clem.). *Neat strawberry-leaf roller*	Id., Papilio, iii, 102.
Tmetocera oceliana (Schiff.). *Eye-spotted bud-moth*	Harris, Ins. Inj. Veg., 482.
Grapholitha prunivora (Walsh). *Plum moth*.....	Riley, Mo. Rept., iii, 6.
Phoxopteris nubeculana (Clem.). *Apple-leaf folder*.....	Riley, Agr. Rept. for 1878, 239.
Carpocapsa pomonella (Linn.). *Codling-moth*.....	Linnæus, Syst. Nat., x, 538.

Pyralidæ.

Eurycreon rantalis Guen. *Pyralid web-caterpillar*.....	Popenoe, Kan. R. B. A., 1880, 100.
Pempelia Hammondi Riley. *Apple-leaf skeletonizer*.....	Riley, Mo. Rept., iv, 44.
Phycis indigenella (Zeller). *Leaf-crumpler*..	Id., ib., 38; as *Phycita nebulo* Walsh.

Tineidæ.

Ypsolophus pomotellus (Harris). *Palmer-worm*.....	Fitch, N. Y. Repts., i–ii, 221.
Ypsolophus contubernalallus (Fitch). *Comrade palmer-worm*.....	Id., ib., 233.
Ypsolophus malifoliellus (Fitch). *Many-striped palmer-worm*.....	Id., ib., 231.
Coleophora malivorella Riley. *Apple-tree case-bearer*....	Riley, Agr. Rept. for 1878, 253.

*This name is proposed in consideration of the preference which the caterpillar shows for the Linden (even above the Elm), as was seen in its devastations of the Lindens in New York city and Brooklyn during at least twenty-five years preceding 1861, when as a means of arresting the nuisance the following resolution was presented to the Common Council of Brooklyn:—

"*Resolved*, That the owners of property having Linden trees on the streets are hereby ordered to remove them within ten days after the passage of this ordinance, and failing to do so, shall be liable to a fine of five dollars for each tree left on the streets, after that date. The street commissioner is hereby directed to remove all trees of that species that may be left on the streets after that date."

The resolution was referred to the Health Committee and Health Officer of the Common Council, who presented a report (of which 1,000 copies were printed), entitled, Report | on the | Measure Worm, | or the | Geometra niveosericearia [Jones], | which | infest the trees of Brooklyn; | suggesting | remedies for their extermination. | By Joseph B. Jones, M. D., | Health Officer. | Health Department, June 1, 1861. | [Seal of City] | Brooklyn. | 1861. | 8 vo., pp. 19.

As the caterpillars were found by the investigations of the above Committee, aided by a Committee of the Brooklyn Sanitary Association, and a Committee appointed at a public meeting of the citizens, to feed upon other shade-trees, several remedies for the nuisance were recommended, in lieu of the measure proposed in the above resolution.

Lithocolletis pomifoliella Zell.* *Thorn-apple leaf-miner.* Clem., P. A. N. S. Ph., 1860, 208.
Tischeria malifoliella Clem. *Apple-leaf miner.* Id., ib., 208.
Aspidisca splendoriferella Clem. *Resplendent shield-bearer.* Comstock, Agr. R. for 1879, 210.
Ornix prunivorella Chamb. *Wild-cherry leaf miner.* Chambers, Can. Ent., v, 50.
Bucculatrix pomifoliella Clem. *Apple-leaf Bucculatrix.* Clem., P. A. N. S. Ph., 1860, 211.
Micropteryx pomivorella Pack. *Apple Micropteryx.* Packard, Inj. Ins., etc., 1870, 6.

Hymenoptera.

Formica Noveboracensis Fitch. *New York ant.* Fitch, N. Y. Reports, i-ii, 63.
Vespa maculata Linn. *White-faced hornet.* Authors.
Vespa vulgaris Linn. *Yellow jacket.* Id.
Polistes fuscata Fabr. *The common wasp.* Id.
Tremex columba Linn. *Pigeon Tremex.* Amer. Entom., ii, 128.

Diptera.

Sciara mali (Fitch). *The Apple midge.* Fitch, N. Y. Reports, i-ii, 252.
Trypeta (Rhagolites) pomonella Walsh. *Apple maggot.* Walsh, Rept. Act. S. E., p. 29.
Drosophila ampelophila Loew. *Pickled-fruit fly.* Comstock, A. Rep. for 1881, 199.
Drosophila amœna Loew. *Pretty pomace fly.* Id., ib., 201.

Coleoptera.

Silvanus Surinamensis (Linn.). *Grain Silvanus.* Glover, Agr. Rept. for 1870, 66.
Trogosita nana (Melsh.). *Dwarf Trogosita.* Riley, Mo. Rept., iii, 6.
Ips fasciatus Oliv. *Banded Ips.* Thomas, Ill. Rept., vi, 91.
Lucanus dama Thunb. *Stag beetle.* Harris, Ins. Inj. Veg., 45.
Serica iricolor (Say). *Iridescent Serica.* Glover, Agr. Rept. for 1868, 87.
Macrodactylus subspinosus (Fabr.). *Rose beetle.* Harris, Ins. Inj. Veg., 36.
Lachnosterna fusca (Frohl.). *May beetle.* Glover, Agr. Rept. for 1868, 104.
Lachnosterna sororia Lec. = (*L. micans.*) Id., ib.
Lachnosterna fraterna (Harris). *June beetle.* Harris, Ins. Inj. Veg., 32.
Lachnosterna hirticula (Knoch). *Hairy May beetle.* Glover, Agr. Rept. for 1868, 88.
Lachnosterna crenulata (Frohl.) Id., ib.
Lachnosterna tristis (Fabr.) = (*L. pilosicollis* Knoch) Harris, Ins. Inj. Veg., 33.
Macronoxia variolosa (Hentz). *Scarred Melolontha.* Id., ib., 33.
Euphoria melancholica (G.-P.). *Melancholy chafer.* Amer. Entomol., ii, 61.
Euphoria Inda (Linn.). *Indian Cetonia.* Riley, Mo. Rept., iii, 6.
Osmoderma eremicola (Knoch). *Hermit Osmoderma.* Harris, Ins. Inj. Veg., 42.
Osmoderma scabra (Beauv.). *Rough Osmoderma.* Glover, Agr. Rept. for 1868, 90.
Dicerca divaricata (Say). *Divaricated Buprestis.* Id., ib., 91.
Chrysobothris femorata (Fabr.). *Flat-headed ap.-tr. borer* Fitch, N. Y. Rept., i, 25.
Alaus oculatus (Linn.). *Eyed Alaus.* Id., ib., iii, 11.
Alaus myops (Fabr.). *Blind Alaus.* Id., ib., iii, 12.
Melanotus incertus (Lec.). *Uncertain snapping-beetle.* Riley, Mo. Rept., iii, 6.
Melanotus communis (Gyll.). *Common snapping-beetle.* Id., ib., 6.
Sinoxylon basilare (Say). *Red-shouldered Sinoxylon.* Id., ib., iv, 54.
Amphicerus bicaudatus (Say). *Apple-twig borer.* Fitch, N. Y. Rept., iii, 12.
Polycaon confertus Lec. Riley, Amer. Nat., xvi, 747.
Prionus laticollis (Drury). *Broad-necked Prionus.* Amer. Entomol., i, 233.
Prionus imbricornis (Linn.). *Tile-horned Prionus.* Riley, Mo. Rept., iii, 6.
Chion garganicus (Fabr.) Fitch, N. Y. Rept., iii, 8.†
Chion cinctus (Drury). *Banded Chion.* Id., ib.
Elaphidion villosum (Fabr.). *Apple-tree pruner.* Riley, Amer. Ent., iii, 239.
Elaphidion parallelum Newm. *Parallel Elaphidion.* Id., ib.

**Lithocolletis cratægella* Clem., is, according to Lord Walsingham (*Trans. Amer. Entomolog. Soc.*, ix, 1882, p. 202), identical with this well-known European species.

† As *Cerasphorus balteatus* De Geer.

Psenocerus supernotatus (Say)..... Packard, Guide St. Ins., 500.
Leptostylus aculifer (Say). *Prickly Leptostylus*..... Fitch, N. Y. Rept., iii, 8.
Sternidius alpha (Say)..... Riley, Amer. Ent., iii, 270.
Liopus facetus Say. *Facetious Liopus*..... Fitch, N. Y. Rept., iv, 65.
Hyperplatys maculatus Hald..... Riley, Amer. Ent., iii, 271.
Oncideres cingulatus (Say). *Twig-girdler*..... Id., ib.
Saperda candida Fabr. *Round-headed ap.-tr. borer*..... Harris, Ins. Inj. Veg., 107.
Saperda cretata Newm..... Osborn, Amer. Nat., xv, 244.
Glyptoscelis crypticus (Say). *Cloaked Chrysomela*..... Fitch, N. Y. Rept., iii, 18.
Diabrotica vittata (Fabr.). *Striped cucumber-beetle*..... Riley, Mo. Rept., iii, 6.
Odontota rosea (Weber). *Rosy Hispa*..... Harris, Ins. Inj. Veg., 120.
Hymenorus obscurus (Say)..... Lintner, Count.-Gent., 1882, 605.
Macrobasis unicolor (Kirby). *Ash-grey blister-beetle*..... Glover, Ag. Rept. for 1868,105.*
Pomphopœa ænea (Say). *Pear-tree blister beetle*..... Riley, Mo. Rept., iii, 6.
Epicærus imbricatus (Say). *Imbricated snout-beetle*..... Glover, Ag. Rept. for 1870, 71.
Ithycerus Noveboracensis (Forst.). *New York weevil*... Fitch, N. Y. Rept., iii, 13.
Anthonomus cratægi Walsh. *Thorn curculio*..... Riley, Amer. Ent., ii, 308.
Anthonomus quadrigibbus Say. *Apple curculio*..... Walsh, Amer. Ent., i, 36.
Conotrachelus nenuphar (Herbst). *Plum curculio*..... Harris, Ins. Inj. Veg., 76.
Monarthrum mali (Fitch). *Apple bark beetle*..... Fitch, N. Y. Rept., iii, 8.
Xyleborus pyri (Peck). *Pear-blight beetle*..... Harris, Ins. Inj. Veg., 90.

Hemiptera.

Heteroptera.†

Nysius destructor Riley. *False chinch-bug*..... Riley, Mo. Rept., v, 112.
Lygus lineolaris (Beauv.). *Little-lined plant-bug*..... Id., ib., ii, 114.‡

Homoptera.

Cicada tibicen Linn. *Dog-day Cicada*..... Uhler, *in lit.*
Cicada septendecim Linn. *Seventeen-year locust*..... Fitch, N. Y. Rept., i, 45.
Cicada tredecim Riley. *Thirteen-year locust*..... Riley, Mo. Rept., iii, 6.
Ceresa bubalus (Fabr.). *Buffalo tree-hopper*..... Id., ib., v, 122.
Ceresa taurina Fitch. *Calf tree-hopper*..... Fitch, N. Y. Rept., iii, 17.
Jassus irroratus Say..... Uhler, *in lit.*
Psylla pyrisuga Forst. *Pear-tree Psylla*..... Glover, Agr. Rept. for 1876, 33.
Aphis mali Fabr. *Apple-tree Aphis*..... Fitch, N. Y. Rept., i, 49.
Aphis malifoliæ Fitch. *Apple-leaf Aphis*..... Id., ib., i, 56.
Schizoneura lanigera Haus. § *Apple-root plant-louse*..... Id., ib., i, 5.
Callipterus mucidus Fitch. *Mouldy Aphis*..... Id., ib., iii, 16.
Aleurodes sp..... Walsh, Pract. Ent., ii, 58.
Chionaspis furfurus (Fitch).‖ *Scurfy bark-louse*..... Id., ib., 31.
Diaspis ostreæformis (Curtis).¶ *Circular bark-louse* (Fitch) Comstock, A. R. for 1880, 312.
Mytilaspis pomicorticis Riley.** *Apple bark-louse*..... Harris, Ins. Inj. Veg., 252.

*As *Macrobasis Fabricii.*

†Dr. Fitch, in his Third-Fifth Reports, pp. 17 and 18, nos. 24 and 26, includes among insects affecting the leaves of apple-trees *Arma grandis* [now *Podisus cynicus* (Say)], and *Arma spinosa* [*Podisus spinosus*], but these are now regarded as cannibals and not vegetable feeders. *Sinea diadema* (Fabr.) and *Milyas cinctus* (Fabr.), which have also been recorded among apple-tree insects, also subsist on the juices of other insects.

‡As *Capsus oblineatus* Say.

§As *Pemphigus pyri* Fitch.

‖*Aspidiotus Harrisii* Walsh.

¶*Aspidiotus circularis* Fitch.

**_Aspidiotus conchiformis_, of Authors.

Aspidiotus perniciosus COMSTOCK. *The pernicious scale*.. Comstock, *sup. cit.*, 304.
Lecanium oleæ BERNARD. *Black scale of California*..... Id., ib., 336.
Thrips sp?..... Osborn, Psyche, iii, 369.
Phlæothrips mali FITCH. *Apple thrips*..... Fitch, N. Y. Rept., i, 102.
Heliothrips hæmorrhoidalis BOUCHE..... Pergande, Psyche, iii, 381.

Orthoptera.

Œcanthus niveus HARRIS. *White flower-cricket* ..... Riley, Mo. Rept., v, 120.
Caloptenus femur-rubrum HARRIS. *Red-legged grasshopper* U. S. Ent. Com. Rept., i, 445.
Caloptenus spretus UHLER. *Rocky Mountain locust*..... Id., ib., 253.
Caloptenus atlanis RILEY. *Atlanis grasshopper*..... Id., ib., 445.
Camnula pellucida SCUDD..... Id., ib.

(C.)

DESCRIPTIONS AND NOTES OF LEPIDOPTERA.

The following papers upon Lepidoptera have already been published in Scientific Journals. They are republished here for convenience of reference, and as being a portion of the work of the Entomologist during the period for which his Report is made.

[*From Papilio, May*, 1881, i, pp. 69–74.]

ON SOME SPECIES OF NISONIADES.

Mr. Wm. H. Edwards has submitted to me for examination some examples of *Nisoniades*, which prove to be undescribed species. They are the following:—

Nisoniades Nævius n. sp.

Size somewhat less than *N. Juvenalis* and *N. funeralis*. Wings fuscous, almost black, with a purple reflection.

Primaries with four minute, subquadrangular, white, costo-apical, hyaline spots, of which the fourth (from costa) may be obsolete; a similar spot in cell 3, and none in the discal cell. An irregular umber-brown spot centers on the discal cross-vein, and at about the middle of cell 1 b (the submedian interspace) is another, showing more distinctly in the ♀. The subterminal row of obscure, rounded, intranervular fuscous spots rest on a dark umber-brown ground. All the markings are nearly lost in the dark ground; those best defined are two confluent trapezoidal spots in cell 1 b, forming the inner termination of the transverse row of spots, and defined without and within by a W in umber-brown. The spots of the transverse row are not of the ordinary sagittate form.

Secondaries dark brown, showing faintly the two rows of intranervular paler brown spots, more distinct in the ♀. Cilia dark brown, lighter upon their outer half in one ♂, and quite pale, approaching whitish in the ♀.

Beneath, paler brown, and showing more or less distinctly the two ordinary lines toward the margin of pale brown spots, and in one ♂ example, a white spot in the discal cell, not seen on the upper surface. Head and palpi concolorous with the thorax, abdomen, and legs.

Expanse of wings: ♂ 1.45 to 1.65 in.; ♀ 1.65 to 1.70 in.

Described from 3 ♂'s, collected at Indian River, Florida.

This species is allied to *N. funeralis* Scudd.-Burg. Its markings are similar in form and arrangement and nearly as inconspicuous, and the pale fringe of the secondaries in one example shows a tendency toward the white fringe of that species. Its wings are not quite so pointed. The examples before me show

none of the bluish hairs which sprinkle the primaries of *N. funeralis* and are still more numerous in *N. Juvenalis* Fabr. and *N. Propertius* Scudd.-Burg.

This may possibly be the *N. Terentius* of Scudd.-Burg., based upon the genital armature; but as the differences presented between the genitalia of this species, which have been carefully observed, and those of *N. Terentius* as described and illustrated, are greater than those which have served to separate other of the genitalic species, it would not be proper to accept the two as identical.

Nisoniades Petronius n. sp.

In ornamentation and general character, allied to *N. Propertius* Scudd.-Burg., resembling it in the quite oblique line of subsagittate black spots crossing the nervules. The black markings of the wings are more strongly contrasted with the dark brown ground than in *N. funeralis* or *N. Nævius*, but less so than in *N. Propertius* and *N. Juvenalis* — about equal to *N. Persius*. The white hyaline spots of the primaries are of medium size — smaller than in the average of *N. Juvenalis;* that in the discal cell is small; that in cell 3 on the transverse line of sagittate spots is crescentic, concave toward the base; below the latter, in cell 2, a smaller white spot, wanting in one example.

Beneath, reddish-brown, especially the secondaries, which show two rows of pale-brown submarginal spots which become obsolete before reaching the front margin of the wing, and wholly want the white spots in cells 6 and 7 which characterize *N. Juvenalis** and *N. Propertius*. The white spots of the primaries are larger than above.

Head: above the eyes and just behind the "locklet" are a few white scales; behind and beneath the eyes are some pale yellow-brown scales, and similar colored hairs compose most of the palpal covering, quite in contrast with the dark-brown color of the legs, thorax and abdomen.

A single ♀, accompanying the examples submitted to me, I refer, somewhat doubtfully to this species, from general markings and the pale-colored palpi. The transverse row of ellipsoidal black spots, and those of the medial and basal regions, are conspicuously outlined on a somewhat pale umber-brown ground — the contrast about that presented in *N. Martialis* ♀. An oval white spot in cell 2 accompanies the round one in cell 3. The costo-apical white spot in cell 9 is wanting.

Expanse of wings: ♂, 1.90 to 2 in.; ? ♀, 1.80 in.

Described from 4 ♂'s and 1 ♀, from Indian River, Florida.

This is the largest species known to us in the genus. It is separable from *N. Juvenalis* and *N. Propertius* by its darker color, less distinct ornamentation, less rounded wings, and absence of the white spots of secondaries in cells 6 and 7. From *N. Nævius* with which it is associated, it is distinguished by its large size, more distinct markings, and the contrasting lighter shade of the palpi.

The genitalia of this species resemble those given for *N. Horatius* and *N. Virgilius*, named from their genital armature, by Scudder and Burgess, but I am unable to refer it to either. Examples from Florida, which Mr. Scudder has kindly permitted me to examine, and labeled by him as *N. Horatius*, have the white hyaline spots of the primaries larger than in the above species, and, ac-

* In 45 examples of *N. Juvenalis* before me, these white spots are a prominent feature. In one example the spots each occupy the entire breadth of the cell.

cording to notes made at the time of their examination, "larger than in any of the *N. Juvenalis* in my collection, except in a single example taken at Center, in which they are about the same in size and similar in form."

Nisoniades Propertius Scudd.-Burg.

Several years ago, through the kindness of Mr. Scudder, I was permitted to examine the species of the *Nisoniades* in his collection, including several of his types. Among them were eight examples, bearing his label of *Propertius*, from the following localities: two from Mokiah Pass, Palmer collection; one from Sierra Nevada; four from California; one from Juniper Mountains.

The following notes upon this species were made by me at the time, upon comparison of the material with the examples of *N. Juvenalis* in my own collection.

Size of *N. Juvenalis;* the primaries more pointed; the submarginal row of sagittate and black spots is more oblique, being more drawn inwardly toward the base as it approaches the internal margin, whence it follows that, while in *Juvenalis*, of the two subelliptical whitish spots in cell 1 b, the lower one is as near to the outer margin as that in cell 3, in this species it is always further removed. The hyaline spot in the discal cell is smaller than in *N. Juvenalis* and is much less conspicuous underneath. Of the four costo-apical hyaline spots, 1, 3 and 4 are in line, or 3 is somewhat nearer to the base of the wing; 2 is nearer the apex and is elongated. The thorax and abdomen are fuscous, instead of umber-brown. In general color it is darker, more approaching *N. Persius* — the black spots not offering so strong a contrast with the ground as in *N. Juvenalis;* the primaries are nearly covered with bluish hairs, which is perhaps the best characteristic feature of the species.

It is very doubtful if the genitalic form, *N. Tibullus* of Scudd.-Burg., can be separated from *N. Propertius.*

This species has also been received from Utah and Arizona. I have also in my collection, examples received from Mr. Henry Edwards (No. 76), from Havilah, California, and Vancouver Island.

Nisoniades Icelus Lintn.

Mr. W. H. Edwards has allowed me to examine two examples of this species, which he had obtained from the Western collections of Mr. Morrison in 1880, taken in Washington Territory. This extreme western locality for this insect is an interesting addition to our knowledge of its distribution. Mr. Scudder in his *Systematic Revision of American Butterflies* (1872), gives as its distribution, Canada to West Virginia; Atlantic Coast to Michigan. In the Edwards' *Catalogue of the Diurnals of North America* (1877), its habitat is given as New England, Middle States and Illinois. Subsequently (my *Entomolog. Contrib.*, No. IV, 1878), I identified it among some Colorado collections of Mr. Morrison. These western examples do not differ in size or in any particular feature from our eastern forms. The examples before me are without date of collection. They are in fresh condition, and are rather more strongly marked with white scales toward the costal and outer margins of the primaries than those ordinarily met with in the Middle and Eastern States.

An interesting feature of this species, observed by Dr. Speyer, is noticed in his valuable paper on the *Genera of the Hesperidæ of the European Faunal-Region*

(Canad. Entomol., x, p. 169). It is the presence of a long and thick tuft of hairs on the posterior tibiæ. This is not found in *N. Brizo* Boisd.-Lec.— a species so closely allied to *N. Icelus* that some writers have questioned their specific difference. It has been observed in but one other species of *Nisoniades*, viz., *N. Persius* Scudd. It also characterizes the Hesperidean genus *Daimia* of Murray, of which the European *D. Tethys* Men. is the type and sole species, and *Scelothrix* of Ramb.—united with *Pyrgus* H. by Dr. Speyer in his last Revision of the European Hesperidæ (1878), as Group II, having *maculatus* Brem, as the type of the group. This tuft or hair-pencil differs in the several species. In *N. Icelus* it is produced from the femoral joint of the tibia, and is widely spread apart in the examples before me. In length it exceeds the tibia by nearly one-half. Like the costal-fold, it is probably confined to the ♂ sex.

A revision of the proof of this paper has enabled me to add the following: Since the above was written, an examination of the *Nisoniades* in my collection has shown the presence of the tibial hair-pencil also in the males of *N. funeralis* Boisd., *N. Nævius* Lintn., and *N. Lucilius* Lintn. I cannot detect it in any other than the above-mentioned five species. In the genus *Pyrgus*, I find it in *P. centaureæ* Ramb., *P. scriptura* Boisd., *P. Xanthus* Edw., *P. Petreius* Edw., and *P. cricetorum* Boisd. It is not present in *P. tessellata* Scudd. Of *P. Oceanus* Edw., *P. Ricara* Edw., *P. Philetas* Edw., and *P. cæspitalis** Boisd., I possess no examples for examination. It exists also in *Achlyodes Thraso* Hübn.

Nisoniades Somnus n. sp.

Belongs to the *N. Icelus* and *N. Brizo* group; size of the former—its wings somewhat narrower and more extended apically.

Male, dark brown in color, approaching *N. Persius*. Primaries, without the ante-apical white spot above, and the large patch of bluish-white scales resting on the discal cross-vein of *N. Icelus*. The black transverse bands are of the position and character of those of *N. Icelus*, but are almost lost in the ground color. Secondaries, nearly as dark as the primaries, showing indistinctly the two rows of pale brown spots.

Beneath, wings bronze by reflection. The primaries have a short costo-apical white streak in cell 8, and a minute white dot in cell 9 (*N. Icelus* has usually a subquadrangular white spot in cells 6, 7 and 8 each, and occasionally the spots form a continuous line nearly across the wing, from 2 to 8 inclusive); an intranervular series of pale streaks, and on the secondaries, the two rows of yellow-brown spots are distinct.

Female, paler brown than the male. The two transverse bands of primaries are quite distinct, and between them, on the discal cross-vein, is a conspicuous patch of whitish scales; no white ante-apical spots; upon the margin, a row of rounded brown spots, separated from the contiguous band, by whitish scales. The bands are broader than in *N. Icelus*, and are almost drawn together on vein 2; the connected series of spots composing each, are shaped much as in *N. Icelus*, are heavily bordered with black, and bear bluish scales. Secondaries, with a geminate discal mark, a submarginal row of yellowish spots much bent inwardly opposite the cell, and a marginal row of small, linear, whitish spots.

Beneath, wings with a strong bronze reflection. The secondaries have the two rows of spots of the upper surface repeated; the primaries have a marginal

* Erroneously given as *Cæspitatis* in Edwards' Catalogue.

row of linear whitish spots, a regularly curved submarginal row of eight oblong yellowish spots, and a single white ante-apical spot in cell 8.

The antennæ, in this species, are delicately annulated with white. The palpi are shorter than in *N. Icelus*, shaggy, some of the hairs of the second joint extending to the tip of the third. The tibiæ of the posterior pair of legs are without the pencil of hairs characterizing *N. Icelus*.

The last-mentioned feature separates, beyond question, this species from *N. Icelus*. It may also be distinguished by the darker and more uniform color of the male, the transverse bands hardly separable from the ground color, the absence of an ante-apical white spot and of the discal patch of bluish scales. The female resembles *N. Brizo*, but the inner margin of the outer band is much more irregular than in that species, and the submarginal row of spots on the primaries beneath, takes the place in prominence, of a different series seen in *N. Brizo*, of which only the costal one is here represented.

Expanse of wings: ♂, 1.30 inch; ♀, 1.45 inch.

Described from 1 ♂ and 1 ♀, in the collection of Mr. W. H. Edwards, received from Indian River, Florida.

The relationship of this species suggests the mythological name given it. Brizo was worshiped as the goddess of sleep. Icelus was regarded as the inspirer of dreams in mortals, and was the son of Somnus, the god of sleep (see 23 *Rept. N. Y. St. Mus. Nat. Hist.*, 1873 p. 163-4).

Eudamus Proteus (Linn.).

Quite an interesting addition to the list of Hesperidæ occurring in the State of New York, is the above species.

Two examples of it, one of which I have been permitted to see, were captured by Mr. S. Lowell Elliot, of New York city, about the middle of August of last year, in the Central Park Gardens, east of the Mt. St. Vincent Art Gallery, upon the flowers of *Salvia splendens*. Other examples of it, as Mr. Elliot informs me, were seen by him, which he was unable to capture, for as soon as they alighted they were attacked by *Eudamus Tityrus*, which swarmed around these flowers and seemed to recognize the *Proteus* as strangers and intruders.

The species was not observed about other flowers, but were seen hovering around the *Salvia* for three consecutive days, when a cold rain storm ensuing and continuing for several days, terminated their visits.

Mr. Scudder reports the species from "Eastern N. America, as far north as Connecticut," but we have not been able to verify its collection in that State. We believe that these are its first captures within the State of New York.

Eudamus Nevada Scudd.

From an example received from Mr. Henry Edwards (No. 2509, Summit Ser. Nev., Cal.), and from an additional example collected by Mr. Nash, of Ithaca, N. Y., in Colorado, I find that the above form is a valid species, quite easily to be separated from *E. Pylades*, of which, at the time of the publication of the Edwards' *Catalogue of the Lepidoptera of America: Diurnals*, it was believed to be a dwarfed variety.

[*From the Canadian Entomologist, April*, 1881, xiii, pp. 63–65.]

DESCRIPTION OF A NEW SPECIES OF EUDAMUS.

EUDAMUS ELECTRA, n. sp.

Size of small *Nisoniades Juvenalis*. Primaries narrower than in *Eudamus Pylades* Scudder ♀, more rounded on the costa, and more oblique on the hind margin. Secondaries rounded, not prolonged at the anal angle as in *E. Pylades*, nor excavated opposite the cell as in most of the Nisoniades.

General color dark brown, approaching that of *E. Pylades;* the fringe concolorous with the terminal portion of the wings, a little paler at their tips.

Primaries with eleven transparent white spots, upon which an ordinary lens shows regular rows of small black scales — the spots, as follows: Near the end of the cell (apparently open) are two spots, separated by the cellular fold and extending to the enclosing veins (subdorsal and median) — the upper one twice as large as the lower and prolonged backward superiorly in one or two teeth — the lower one subtriangular in shape; above and in line with these two, in cell 10, is a small elongated spot — the smallest on the wing, while beneath them and in range, in cell 2, extending from vein 2 to vein 3, is the largest spot on the wing, enlarged superiorly and excavated inwardly. Outside of this discal band of four spots, are seven others, bordered by dark brown, and arranged in an irregular curve, as follows: in cells 9, 8 and 7, three costo-apical spots, oblique to the costa; outside of these, in cell 6, a spot; in cell 5, still nearer the margin, another; in cell 4, a little farther removed from the margin, another — these last three subtriangular in shape; in cell 3, extending from vein to vein, a subquadrate spot, placed farther from the margin, about equidistant with the lower costo-apical spot; these seven spots, commencing at the costa and omitting the fifth, show a regular increase in size. Outside of these transparent spots, is a series of obscure dark brown intranervular subterminal spots which merge into the dark brown shade of the margin. Inside of these spots, the wing shows by oblique light a purplish reflection approaching a grape bloom but more vivid, with the exception of the internal margin and two brown bands of the color of the outer margin and posterior wings; the bands extend from the subcostal to the internal vein; the outer and broader embraces the discal band of transparent spots in its outer margin, and the other crosses the median vein at its intersection by vein 2; a brown shade rests also on the base of the wing.

Secondaries traversed at about their outer third by a narrow obscure brown band, inside of which the wing is dark brown; outside of this band, the subterminal series of brown spots of the primaries is continued.

Beneath, the purplish reflection of the upper surface appears only at the tip of the wing — the median and basal portions being dark brown, concolorous with the secondaries inside of the paler brown band; the obscure intranervular brown spots of the upper surface are repeated, and continued on the secondaries; the transparent spots are without the lines of brown scales.

The costal vein of the primaries intersects the costa nearly opposite the end of the cell; vein 8 reaches the margin at the extreme apex — not below it.

Antennæ about one-half the length of the anterior wings, dark reddish-brown, marked inwardly with white at the joints, expanding rapidly into the club (the terminal half of the club lost).

Palpi in length about equal to the diameter of the eyes, clothed with thick, bristly, dark brown hairs, some of which are white tipped; apical joint short, conical, projecting a little beyond the hairs.

Locklet black, curving about half-way over the eyes. Front of head dark brown.

Thorax above and beneath clothed with long brown hairs, concolorous with the posterior wings.

Abdomen darker brown, reaching only to the pale band of the hind wings.

Legs dark brown; the posterior pair have the femur and tibia of the same length, bearing brown hairs which nearly equal them in length; tibiæ armed with two pairs of spurs; tarsi twice as long as the tibiæ, moderately spinose.

Expanse of wings, 1.65 in.; length of body 0.55 in.

Described from a single female received from Mr. W. H. Edwards. The specimen was captured in Hamilton, Ontario, by Mr. J. Alston Moffat, in 1877, in company with another like it, which escaped capture.

In the *Hesperida* the antennal club affords excellent generic features. It is unfortunate that in this unique specimen, the half of one antenna and the terminal half of the club of the other, have been lost. It being also of the female sex, we are without knowledge of the presence or absence of a costal fold in this species. In the absence of these characters, it is referred, with some doubt, to the genus *Eudamus*, in which Dr. Herrich-Schaeffer, Dr. Speyer and others arrange species with rounded hind wings and those in which they are greatly prolonged. Of the three groups in which Dr. Speyer has divided the genus, viz., "Hind wings on submedian nervure little or not at all produced. — Prolonged in a lobe, — *** Caudated,— *E. Electra* falls in the first group.

The detection of the above species is a very interesting discovery for this portion of the United States.

[*From the Canadian Entomologist, November*, 1881, xiii, pp. 218-220.]

ON THE LIFE DURATION OF THE HETEROCERA (MOTHS).

Read before the American Association for the Advancement of Science, at its Cincinnati Meeting, August, 1881.

I have been requested by Mr. Edwards, who has presented to the Association an interesting and valuable paper, "On the Length of Life of Butterflies," to supplement it with some remarks on the *Life Duration of the Heterocera.*

The period of time passed by insects in their perfect stage is an item in their history to which, so far as I know, very little attention has been paid. It has not hitherto been made a special subject of inquiry. When we seek to answer the question, we find that very few of our published observations bear upon it. The little that is known upon this point, in the Heterocera, would not authorize the presentation of these notes before this body, were it not that a confession of our ignorance should, and I hope may, serve as an incentive to the examination of the interesting question.

It must prove a difficult field of investigation. Observations made upon species in confinement, deprived of food and subjected to other unnatural conditions,

would give only approximate results. Even here we find our knowledge extremely limited. Outside of the *Sphingidæ* and the *Bombycidæ*, scarcely any thing has been done by our Lepidopterists in rearing entire broods of species. In these two families the eggs can be easily obtained, either by the "sembling" method (attraction of the male by a newly-emerged female) or by simply pinning out of doors a captured female. Several species of the *Phalænidæ* are quite prompt in extruding their eggs upon being pinned, even after having been temporarily subjected to anæsthetic influence. But in the extensive family of *Noctuidæ* — with the winged forms of which we are so familiar, and of which our knowledge, therefore, should be the more complete — it is difficult to obtain the eggs under the restraint of confinement. I have never carried an oviposition of a single Noctuid to the perfect stage, nor can I recall a published record of its having been done. Further, in illustration of the veil that still hides portions of the life-histories of these forms which rarely obtrude themselves upon our sight except under cover of the night, it may be mentioned that during the thirty years in which my studies have engaged me to a greater or less extent in the rearing of Lepidoptera, I do not recall an instance where I have observed the *Noctuidæ in coitu*, and therefore have no personal knowledge of the time, place, manner or duration of the initiative of Noctuid life.

It is known that in the *Attacina*, among the *Bombycidæ*, in confinement, the lives of the moths are very brief. The sexes mate a few hours after emerging from the pupæ, and continue in copulation for twenty-four hours or more. Oviposition may be commenced the following day, and completed within four or five days thereafter. Perhaps a week longer will complete the life-period of the female—extending in all to about fifteen days. The male usually dies a few days after copulation—several days before the female.

In the *Sphingidæ*, the lives as observed, in confinement, are longer than in the *Attacinæ*, but I have no records from which to give comparative duration. Our observations upon the *Phalænida* lead us to believe that, as a general rule, their lives are shorter than are those of the *Noctuidæ*.

An approximation to the life-period of the *Noctuida* may be obtained from the dates when the several species are observed abroad. The published records of the collections made by "sugaring" will furnish convenient data for this. I regret that at my present writing, away from books of reference, I am unable to refer to the papers of Messrs. Thaxter, Norman, Westcott* and others. From a paper published by myself in *Entomolog. Contrib.*, iv, pp. 43-51, it appears that the period of collection (embracing probably nearly the entire life-period, as the examples when first taken at sugar were apparently just from pupæ, and those last taken so worn as to be hardly capable of flight) of quite a number of species was about one month. Among these may be mentioned *Habrosyne scripta*, *Agrotis baja*, *A. subgothica*, *A. bicarnea*, *A. repentis*,† *Hadena verbascoides*, *Gortyna sera*, *G. nictitans*, *Leucania pallens*, *L. phragmitidicola*, *L. lapidaria*, *L. pseudargyria*, *Orthodes infirma*, *Orthosia helva*, *Scoliopteryx libatrix* and *Pseudaglossa lubricalis*.

If, in consideration of the condition of the moths when captured, the probable different time of oviposition and more or less favorable exposure of eggs, we as-

* *Psyche*, ii, pp. 34-38, 80; *Canad. Entomol.*, vii, pp. 3, 21; *Id.*, viii, p. 12.

† Now regarded as distinct from *A. messoria* Harris.

sume that the individuals of a species continue to emerge from the pupa during one-third of the above period, there will remain, as the approximate life duration of these *Noctuidæ, a period of three weeks.*

Mr. Wm. L. Devereaux, of Clyde, N. Y., in giving the results of his collections of *Noctuida* at sugar for two years,* states that "most of the species remain for about a month." From other data which I have consulted, I think that we shall not be far from the truth if we adopt as the life-period of the larger portion of the *Noctuidæ* a term of three weeks.

As might be expected in so heterogeneous a family as the *Noctuidæ* — differing so greatly in general character, coming forth at such different seasons of the year, and varying in the number of the broods,— the life-histories of the several groups vary to the extent of preventing generalization and necessitating specific observations. For example, we find that the genera *Xylina*, *Homoptera*, and *Catocala* have their periods of apparition much extended beyond the species above noticed. In the paper by myself, above referred to (p. 51), we find that *Xylina petulca*, *X. disposita* and *X. Bethunei* were observed for a period extending over forty-one, forty-seven, and fifty one days respectively, with a possible prolongation of the lives of some of their later individuals through hibernation and reappearance in the following spring, of six additional months. Seven species of *Catocala* give an average duration of forty-five days; and from Mr. Devereaux's observations, nine species of *Catocala* give an average period of fifty-seven days. These last may have shown a prolonged period from their record extending over two years — one of which years, from a more favorable season, may have included earlier dates of first appearance. It is proper to state that the above species were selected from the lists, as having been observed for the greatest length of time; the larger number gave considerably shorter terms of apparition.

In concluding these brief notes, which are quite unsatisfactory to the writer, and offered only in compliance with request, I would beg leave to suggest that good service may be rendered to Entomology by the collation from published records, and incorporation in our published lists of insects hereafter, of the several dates of their collection or observation throughout the entire time of their appearance. The want of such data has been felt in the attempt to answer the question of Dr. Weismann, [†] as to the duration of life of some of our insects in their perfect state. It would also be of service in the determination of the number of annual broods; it would afford a knowledge of the time for guarding against the initiative of insect attack, it would enable us in many cases to decide upon the best time for putting in our crops; it would enable collectors to seek for specimens for their cabinets when they are to be found: in short, it would furnish an essential part of the life-histories of our species. I commend it to the attention of Entomologists.

Canadian Entomologist, vol. xi, 1879, pp. 105–109.

[†Dr. August Weismann, of Freiburg in Baden, Germany, had applied to Mr. W. H. Edwards for this information.]

(D.)

ADDENDA.

INCREASED PRODUCTION OF PYRETHRUM INSECT-POWDER; page 37.—That the promise of Mr. Milco of a great reduction in price of the "Buhach" is about to be fulfilled, may be inferred from the following statement recently made:

Mr. G. N. Milco, superintendent of the Buhach Producing and Manufacturing Co., Stockton, Cala., estimates this year's Pyrethrum crop of the company's farm in Mercer county, to be at least forty tons. (*American Naturalist*, June, 1883, xvii, p. 666.)

PARAFFINE AS AN INSECTICIDE: page 46.—An English horticulturist gives the following directions for the use of paraffine, which he says he finds the best of all insecticides for the greenhouse: "I mix it thus: to half a pound of soft-soap, I add one pint of hot water, stir until the soap is thoroughly dissolved, then add half a pint of paraffine and stir well: to this I add two quarts more of hot water, and put the whole into a stone bottle and shake it well before using. This I always have in readiness, and for syringing or sponging we dilute it as may be necessary. It mixes readily with cold water, and thus mixed may be safely applied to any plant."

LUCILIA SP.: page 62, foot-note.—The parent of the "screw-worm" long known as a serious pest to horses and cattle in Central America, has recently been ascertained to be *Lucilia* (*Compsomyia*) *macellaria*, Fabr. For an interesting account of its attack upon man—in several instances proving fatal—see a paper by Prof. F. H. Snow, in *Psyche*, 1883, iv, pp. 27–30.

REMEDY FOR THE COCKROACH: page 65.—Powdered borax has inadvertently been given as a *repellant* of the cockroach and the croton-bug. It should have been included among the remedies, as it is perhaps the most simple and effectual means for killing them that can be employed. In a house badly infested with them, a pound of the powder was strewn over the floors of two basement rooms, and along the wainscoting of others. When the house was opened after having been closed for a fortnight, thousands of the dead bodies of the two species were scattered over the floors, and a few were still giving evidence of life. What seemed dust upon a portion of a pantry, was found to be

myriads of the dead bodies of young individuals, apparently a few days from the egg.

HELIOTHIS ARMIGER *Hübn.;* page 116.—Add to the bibliography, WALSH: in Pract. Entomol., ii, 1866, pp. 21, 22 (larval habits and description); Ib., pp. 34, 112 (brief notices).

BUCCULATRIX POMIFOLIELLA *Clem.;* page 157.—In the *Canadian Entomologist*, vol. xiv, 1882, pp. 153–160, Mr. V. T. Chambers, in a paper entitled "Notes on the Larva of *Bucculatrix ambrosiæfoliella*," presents valuable information upon the natural history of the species, the larval structure, and a very interesting account of the manner in which it builds its peculiar ribbed cocoon. The details given will probably apply, in the greater part, to its congenor, *B. pomifoliella*, to which references are made in the paper.

PUPA OF MEROMYZA AMERICANA, page 222.—When the examples of the transformed larvæ referred to came under my observation, the external features of the pupa were so well-defined, that, not being reminded at the time of its necessarily coarctate form, the puparium was not noticed. My attention having recently been called to this feature of the insect, by an inquiry of Professor Forbes, I am led to believe, from my recollection of the specimens, that the pupæ were enveloped in a thin, transparent and closely adhering puparium. Such puparia are recorded of species of *Chlorops*—nearly allied forms, and occurring under almost identical conditions.

A Western locality for this Fly, showing for it quite an extensive distribution throughout the United States, is that given by P. R. Uhler, in *Bull. U. S. Geolog.-Geograph. Surv. Terr.*, iii, 1877, p. 783, where it is stated to be "a very common species upon weeds in damp places near Denver [Colorado], Aug. 5–18," as observed in the explorations of 1875.

According to Prof. Forbes, the insect has the present season (spring of 1883) been very destructive to winter wheat in Central and Southern Illinois, destroying entire fields so that they were plowed up for other crops.*

PROTECTION OF GRAPE-VINES FROM THE ROSE-BEETLE; page 232. —A writer in the *Cultivator* for May, 1851 (p. 174), states, that if the vines are laid upon the ground before they put forth their leaves, and are allowed to remain until the beetles have disappeared, or until the grapes begin to have a sour taste, which they generally acquire when they attain the size of large shot, they will entirely escape the attack of the beetle. After this, the vines should be raised and attached to their proper support. The writer gives minute directions for handling the vines.

* *A New Wheat Insect. Wheat-bulb-worm.* By S. A. Forbes, State Entomologist. Normal, Ill., April 12, 1883.

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[Issued, October, 1883.]

ERRATA.

Page 15, line 18, for these read those.
Page 18, line 4, for *and* read and.
Page 20, line 19, for Ratz- read Ratze-.
Page 25, line 5, *dele* 5.
Page 43, line 28, for wooly-apple louse read wooly apple-louse.
Page 45, line 7, for *curculionidæ* read *Curculionidæ.*
Page 58, line 6, for *Chrisobothris* read *Chrysobothris.*
Page 87, line 38, for ii read iii.
Page 99, line 9, for **Guenee** read Guenée.
Page 108, line 40, and page 229, line 23, for omniverous read omnivorous.
Page 115, line 2, for *Gortyra* read *Gortyna.*
Page 126, line 4, after page insert 148.
Page 127, line 14, for Ogs. read Ogd.
Page 171, line 35, for *alcathoe* read *Alcathoe.*
Page 172, and page 206, last lines, for ‡ read †.
Page 191, line 9, for WEIDEMANN read WIEDEMANN.
Page 199, line 37, for ANTHOMYIDÆ read ANTHOMYIIDÆ.
Page 204, beneath left-hand figure insert *a*, and beneath the other, *b*.
Page 248, line 10, for Popenœ read Popenoe.
Page 253, line 5, for Sturtevent read Sturtevant.
Page 272, line 2 from bottom, for decidely read decidedly.
Page 285, line 10, for *parellela* read *parallela.*
Page 301, line 24, for *auriantica* read *aurantiaca.*
Page 329, line 28, for contubernalallus read contubernalellus.
Page 330, line 31, for Macronoxia read Polyphylla.
Page 330, line 37, for *Flat-header* read *Flat-headed.*
Page 331, line 3, for Sternidius read Liopus.
Page 331, line 4, change to Lepturgus facetus SAY. *Graceful Lepturgus.*

Page 42, line 34, and page 247, line 15, *dele* the comma after *cerasi* and *opimus.*
Page 80, lines 5, 6, 7, 17, *dele* the period after the species.
Page 160, line 28, for BUCCULATRIX read BUCCULATRICIS, and correct in Index.
Page 215, line 34, change the comma to a period.
Page 226, line 35, after different insert class of the.
Page 296, line 21, read two of the three bound volumes.
Page 349, *dele* the comma from Bucculatrix, pomifoliella.
Page of Errata, *dele* the first line.

SECOND ANNUAL REPORT

ON THE

INJURIOUS AND OTHER INSECTS

OF THE

STATE OF NEW YORK.

MADE TO THE STATE LEGISLATURE, PURSUANT TO CHAPTER 377 OF THE LAWS OF 1881.

By J. A. LINTNER,

STATE ENTOMOLOGIST.

ISSUED JANUARY 1886.

ALBANY:
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1885.

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No. 162.

IN ASSEMBLY,

APRIL 2, 1885.

SECOND REPORT

OF THE STATE ENTOMOLOGIST, ON THE INJURIOUS AND OTHER INSECTS OF THE STATE OF NEW YORK.

OFFICE OF THE STATE ENTOMOLOGIST,
ALBANY, *March* 12, 1885.

To the Hon. GEORGE Z. ERWIN,

Speaker of the Assembly:

SIR — I have the honor to transmit herewith, to the Legislature, pursuant to Chapter 377 of the Laws of 1881, the Second Report on the Injurious and Other Insects of the State of New York.

I remain very respectfully, your obedient servant,

J. A. LINTNER,
State Entomologist.

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REPORT.

INTRODUCTION.

To the Legislature of the State of New York:

The Entomologist, in presenting his Second Report on the Injurious and other Insects of the State of New York, begs leave to state:

The delay of nearly a year in the printing of the First Report afforded the opportunity of earlier publication of considerable material that had been prepared for the following report. Much of this material was accordingly incorporated with the first, which, still longer delayed by the additions, was not published until in October of 1883.

The present publication presents mainly studies and observations made in the years 1882 and 1883, although embracing some of those of a later date. During these two years, the agricultural interests of the State did not suffer from insect depredations to an extent equaling that reported for the preceding year. No formidable insect pest presented itself for the first time, as a depredator upon any of the principal field or garden crops, to be added to our already large list of insect enemies. The years, of late, in which such additions have not been made, are unfortunately exceptional ones.

The zebra caterpillar of *Mamestra picta* Harris, was unusually abundant during the autumn of 1883, not only in the State of New York, but also in some of the adjoining States. A severe attack of it on beets (mangolds) was reported by Secretary Harison, of the New York State Agricultural Society, as occurring upon his farm at Morely, St. Lawrence Co. The caterpillars were first observed feeding upon the leaves in September. They continued their destructive work into October, until they had devoured all of the tender leaves and reduced the aggregate of the foliage at least one-half. After this had been done, they attacked the roots, into which they made large surface excavations similar to those eaten by crickets into fallen apples. When the mangolds were taken up on the 15th of October, the caterpillars, as stated by Mr. Harison, were still at work upon them, although some severe

frosts (23° and 24° Fahr.) had made them somewhat sluggish in their movements. It was estimated that the yield of the crop had been lessened one-half by the attack of the insect upon it. Quite a number of kinds of garden vegetables were also preyed upon by the Mamestra larvæ, but without committing serious injury. Their favorite garden food-plant seemed to be sweet pea-vines — a long and dense row of which proved very attractive to them. In Massachusetts they have occasionally been extremely destructive to the rutabaga crop. Figures and notice of the insect may be found in Dr. Harris' *Treatise on Insects Injurious to Vegetation*, and in the Report of the Entomologist of the U. S. Department of Agriculture for the year 1883.

The attack upon the pastures and other grass lands in the northern counties of the State by the Vagabond Crambus, *Crambus vulgivagellus* Clem., which was the occasion of so great alarm and of serious loss during the summer of 1881, was not repeated the following year. In accordance with the opinion expressed in my report upon the insect, it proved to be but an exceptional occurrence, resulting from a combination of circumstances which may not again be presented for a long period of time.

The attack of the Corn-worm, *Heliothis armiger* Hübn., upon the corn fields of the southern portion of the State, as a consequence of the unusual heat and drouth of the summer of 1881, was not repeated. Its occurrence within our borders subsequently, has in no instance come to my knowledge.

The injury to clover-seed, from the clover-seed midge, *Cecidomyia leguminicola* Lintn., does not appear to be on the increase in the localities where it had formerly been so abundant, thus affording ground for hope that it may not prove so disastrous to clover culture as it threatened to be, but that the parasites that have attacked it (of which two species are known, *Eurytoma funebris* and *Platygaster error*), are rendering efficient service in its destruction. It seems, however, destined to attain to an extensive distribution, for not only has it reached the extreme western portion of New York, but it has extended into Canada, and excited no little alarm from the amount of clover-seed already destroyed by it. According to the report of the recently appointed Entomologist of the Dominion of Canada, Mr. James Fletcher, the insect is proving even more destructive in its northern extension than in our own State where its operations were first noticed. A few years ago large quantities of Canadian seed were exported to the United States, while at the present not enough is produced for home use. In portions of Ontario, seed clover is reported as an entire failure, as the result of the prevalence of the midge. The first complete destruction

of the seed crops in the Dominion, was observed in the year 1883. To the southward of New York the insect is occurring in Pennsylvania and Virginia.

The punctured clover-leaf weevil, *Phytonomus punctatus* (Fabr.), has also steadily and rapidly extended its area of operations from Yates county where it was at first observed in 1881, northwardly to Lake Ontario, and westwardly, to and beyond Niagara river. In August of 1884, large numbers of the beetle carried in their flight by severe easterly winds, were observed on the sidewalks, in the streets, and on house-tops in Buffalo. Thousands were crushed under foot on the pavements by pedestrians. Many were borne westward and dropped into Lake Erie, from the surface of which they were blown upon the shore where they were found in millions, unfortunately not dead, but soon recovering from the effects of their exposure in the water. Many at the same time were observed upon sidewalks, fences and trees at Ridgeway in Canada, ten miles to the west of Buffalo.

The Colorado potato-beetle, *Doryphora decemlineata* (Say), seems to be diminishing. The experience with it in various portions of the State is, that it has been brought under comparatively easy control. Usually a single application of Paris green made early in the season for the destruction of the first brood is all that is required. The diminution in its numbers is believed to be largely owing to the increase of the insects and other animals that feed upon it. In several localities, species not previously known to attack it, are reported from time to time, as making it their prey, as they come to find it convenient and agreeable for food.

The same decrease in its ravages has been noticed in other States. In Pennsylvania and Ohio, according to a statement made by Prof. E. W. Claypole (*American Naturalist*, xvii, 1883, pp. 1174–1175), there was no second brood in 1882, and in the following year, it almost failed to appear at all. Hot and dry summers have been found favorable for its increase, and upon the recurrence of such seasons hereafter, especial care may be required in order that the destructive insect shall not be allowed again to obtain the ascendancy.

Severe injuries have been reported from different localities in the State, to grass, from the destruction of its roots, by the grubs of the common May-beetle, *Lachnosterna fusca* (Frohl.). Hitherto this insect has been one which has almost defied all efforts made for its destruction, but from experiments now being conducted in a quite new direction, results are anticipated which will enable us to control its ravages in a large degree.

The unusual occurrence of immense numbers of grasshoppers in

midwinter, while the fields were still largely covered with snow, in some of the southern counties of the State, excited apprehension of serious depredations from their multiplication in the spring and summer. Assurance was given that such fears were groundless, and that the premature appearance of the insect — brought out from hibernation by some warm days in February — would only tend to their destruction, and a consequent diminution of their number and of their injuries in the coming season. An account of the grasshopper, *Chimarocephala viridifasciata* will be given in the present report.

A notable event in the autumn of 1883, was the discovery for the first time in injurious numbers in the State of New York, of the chinchbug, *Blissus leucopterus* (Say) — one of the most dreaded of our insect pests. Its attack was made upon clover, and so severe was it, that many acres of meadow were destroyed in the localities where it made its demonstration. Fortunately the fears that were entertained of its continuance and increase in the following years, were not realized. It has, however, shown its ability at any time when favorable conditions are offered it, of entering upon our grass and grain lands and occasioning severe losses. Several pages of this report have therefore been devoted to the consideration of its natural history, habits, its injuries, etc., with the view of presenting such information as will be found of service in meeting its possible future visitations.

In conclusion, the Entomologist desires to express his regret that the figures illustrating this report are not of the number, and some of them, not of the character, needed for its proper illustration. Under the existing arrangements for the printing of the State reports, the number and the style of execution of the figures that may be introduced, are under the control of the State Printers. To this reason it is owing that the original figures contained in the present report are comparatively few. The following have been engraved for it: Figs. 3, 6a, 11, 12, 13, 14, 16, 21, 22, 23, 25, 26, 34, 36, 40, 41, 42, 43, 50, 52, 53, 55, 56, 57. The remaining ones are from electrotypes obtained from various sources, most of which are indicated in the figures and need not, therefore, be separately mentioned. Many of them will be familiar to entomologists, who do not need their aid; but they cannot but prove new and serviceable to a large portion of our agricultural community, for whom this report is specially prepared. Many years must elapse before good figures of any of our common and more destructive insect pests can be repeated so often that a general familiarity with them and the species that they represent in nature, shall render their further repetition useless.

Respectfully submitted,

J. A. LINTNER.

OFFICE OF THE STATE ENTOMOLOGIST,
ALBANY, *March* 10, 1885.

NOTES OF VARIOUS INSECT ATTACKS.

A Saw-fly Attack upon Pear-trees.

Mr. S. D. Willard, of the Hammond Nurseries, Geneva, N. Y., sends, under date of May 29th, examples of a saw-fly, the larvæ of which were proving very injurious to the tender leaves of young pear-trees, just as they were commencing their growth. The examples were in very poor condition, having been almost destroyed in their capture. They were sent to Mr. E. Norton, of Farmington, Conn., in the hope that they would be recognized by him, but he was only able to refer them, with some doubt, to *Pristophora*, allied to *grossulariæ*, but probably an undescribed species. Some of the young larvæ were subsequently received, but they came in too poor condition to permit of their being carried to maturity. A later request for additional larvæ (June 12th), could not be complied with, as they had all been killed by an application of hellebore.

Peach-tree Attacks.

A correspondent sends the following communication containing inquiries of insects attacking his peach-trees:

Is there no remedy against the peach-tree borer except getting it out of the roots with a wire? I have been caused much trouble by this pest, the trunks of my peach-trees being terribly cut and scarified from just under the earth down into the roots. It is laborious in the extreme to cut them out two or three times a year; for it is next to impossible to get them all at the first trial. How would an application of coal-oil do? Would it kill the tree? Will ashes spread around keep the insect from laying the eggs?

In addition to the grub or borer, which is a fat white worm, half an inch in length, with a brown head, and which is found snugly ensconced under the bark after being followed through his various meanderings, I find numbers of fine, white, thread-like worms, of all lengths, from a quarter of an inch to an inch. They also seem to be doing injury, but are found behind the grub in the soft sticky wood. I also find the common earth-worm imbedded in this part of the tree, but think that the latter may be attracted by the moisture caused by the sap exuding from the wounds, and intends no harm. Am I right? Is not the worm found in peaches and caused by curculio, almost exactly like this borer of the bark? Please be kind enough to tell me something of the habits of the two beetles, when the eggs are laid, etc.

Can you tell me also, what causes the fungoid growth upon the pieces of the peach-tree sent?

In addition to the most effectual means of destroying the peach-tree borer, *Ægeria exitiosa* Say, viz., that of digging them out of their burrows which is regarded by many peach growers as not a laborious or difficult operation — the application of hot water to the base of the tree has been recommended, and in many cases has proved quite successful.

Mounding to prevent the peach-tree borer. — The trees of an orchard having been once thoroughly "wormed," preventive measures should be resorted to, that they may not be restocked with the borers. There is good evidence that this is practicable in all but quite young trees by the method known as *mounding*. It is simply the throwing up around the base of the tree, at any time before the parent moths are abroad for the deposit of their eggs (usually in the month of July), a mound of earth of about a foot in height, pressed by the foot closely to the tree. In the following years a few inches of earth may be added annually. By this means, the roots of the tree where they are given off from the trunk, are placed out of reach of the insect. The mounding is believed also to have a beneficial influence on the health of the trees in prolonging their period of bearing and exempting them from disease. Several extensive peach growers claim for this method that it has given them entire exemption from the ravages of the borer, at the cost of a very little labor — one man being able to mound fifty trees in a day. A mound of ashes might prove quite as effectual as one of earth.

Coal-oil application not safe. — The application of coal-oil to the trunk of the tree, which is suggested, would be a hazardous experiment, unless first tried upon a tree or two, for it has been known not unfrequently to kill the trees that have been treated with it. At certain seasons of the year, coal-oil has been applied to the bark of trees for killing scale insects, with scarcely any harm resulting from its use.

Dipterous larvæ. — The "fine, white, thread-like worms," associated with the borers in their burrows, are the larvæ of some species of fly, which have not, so far as we know, been carried to their final stage. They are harmless scavengers, as they feed upon the exuding sap and gummy matter. Some of the smaller myriapods, or hundred-legged worms also frequent the decayed bark and wood of the injured peach-trees. The earth-worms observed, as supposed, are not injurious.

The curculio in the peach. — "The worm found in the peach and caused by the curculio," is very unlike the peach-tree borer, it being the larva of a beetle, *Conotrachelus nenuphar* (Herbst), appearing as a yellowish-white footless grub, with a yellow head and two pale lateral

lines on its body; its length at maturity is about one-third of an inch. The peach-tree borer is the larva of a moth, and is a caterpillar (not a grub) with sixteen legs. When full-grown it exceeds a half-inch in length. The moth deposits its eggs in the crevices of the bark just above the surface of the ground. The curculio beetle cuts with its beak a crescent-shaped incision in the plum into which it inserts its egg. It will thus be seen that the appearance and habits of the two insects are widely different.

The fungus on the peach twigs. — The fungoid growth upon the peach twigs is the common fungus, *Stereum complicatum*, as determined by the State Botanist, Prof. C. H. Peck. This fungus is by no means peculiar to the peach, but is common everywhere on dead and decaying wood, and does no injury to living plants.

Apple-tree Attack by the Canker-worm.

Inquiries similar to the following are frequently received from various parts of the United States, particularly from the New England States, and with increasing frequency from localities in the State of New York:

I send you by to-day's mail a sample of worms I find in my apple orchard, suspended by a single thread from the branches. Are they army-worms, and what is the best way to destroy them? There are more this year than last, and the orchard of 2,000 trees presents a brown appearance after they have fed on the leaves for a while. (W. E., Carrolton, Ky., April 28.)

The caterpillar sent is the spring canker-worm, *Anisopteryx vernata*, of which, notwithstanding so much has been written, many persons are yet entirely ignorant, from the fact that although the species has a very extensive distribution, yet it is quite local in its appearance, prevailing, perhaps, in one or two counties of a State, or it may be in one or two orchards in a locality. This is owing to the fact that the female is wingless, and, therefore, its distribution must usually depend upon assistance afforded it in passing from one orchard, or an isolated tree, to another.

Extensive range of the canker-worm. — It is capable of becoming a great pest — one of the greatest with which the orchardist has to contend. Its distribution is from Maine to Texas, and it has been very destructive in Massachusetts, Illinois, Missouri, Wisconsin, Ohio, and in some other States.

Birds that prey upon it. — Where birds have been protected, they are often the means of preventing its great increase, for several species prey eagerly upon it, and during the time of its prevalence find in it by far the larger portion of their food. The cedar bird (*Ampelis cedrorum*), de-

vours large numbers, and a flock of them in an orchard can render most excellent service in their destruction. As many as one hundred of the caterpillars have been found in the stomach of one of these birds. Next in usefulness come the indigo bird (*Passerina cyanea*), the chickadee (*Parus atricapillus*), the black-billed cuckoo (*Coccygus erythropthalmus*), the summer warbler (*Dendræca æstiva*), the rose-breasted grosbeak (*Goniaphea ludoviciana*), the blue bird (*Sialia sialis*), the king bird (*Tyrannus carolinensis*) and the robin (*Merula migratoria*), in the order mentioned, as shown by examination of the contents of their stomachs by Prof. Forbes.

Climbing habit of the female moth. — It is not safe, however, in the presence of so dangerous an enemy, to commit our apple-trees to the care of the birds; but earnest efforts should be made to confine the attack to the narrowest possible limits, and to arrest it as soon as possible. By far the best method to employ with this insect pest is prevention. The wingless moths emerge from their pupæ in early spring, buried a few inches in the ground about the trunk of the tree in quite a limited space — the larger portion in a circle, the radius of which would not exceed six feet. As soon as extricated from the pupæ, the moths direct their course toward the tree, to ascend the trunk, and deposit their burden of eggs in the crevices of the rough bark of the upper portion of the trunk.

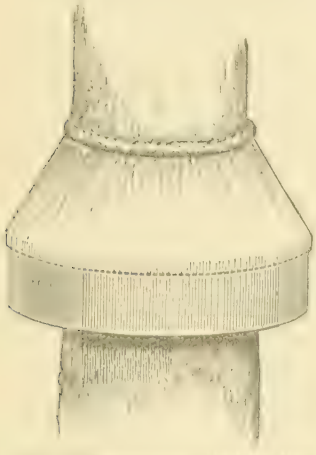
Tar bands for arresting the moth. — The ascent of the trunk should not be permitted, for it can be prevented with comparatively little labor. The method adopted with excellent success for many years was that of encircling the trunks a short distance above the ground, with a band of heavy cloth, to be covered with tar, or better, tar and molasses; to be renewed every two or three days, or whenever it becomes so hardened by exposure as no longer to serve the purpose of fastening the moths which attempt to cross it in their ascent.

Tin-band protector. — A still better method than this has since been devised, and is thus described by Dr. Le Baron in his second report as State Entomologist of Illinois: "Take a piece of inch rope — old, worn-out rope is just as good as new; tack one end to the trunk, two feet or less from the ground, with a shingle-nail driven in so that the head shall not project beyond the level of the rope; bring the rope around the tree, and let it lap by the beginning an inch or two; cut it off and fasten it in the same manner. Get the tinman to cut up some sheets of tin into strips four inches wide, and fasten them together endwise, so that they shall be long enough to go round the trees over the rope band, having the rope at the middle. Let the ends of the tin lap a little; punch a hole through them and fasten them with a nail driven through the tin and rope into the tree."

The operation of this is simple. The moths ascend the tree to the rope and here congregate, for it appears to be entirely contrary to their nature to travel downward. When the space between the tree and trunk has become filled with them, then the new-comers may pass over their compacted bodies, and by dint of effort ascend the outside of the tin; but reaching its upper edge, observation shows that they will not descend upon the inside, but travel round and round the upper edge until they abandon the attempt to reach the tree, and fall to the ground.

Other methods have been used for preventing the ascent of the moths but none seem to be so simple and effectual as the above. A somewhat similar one, upon the same general principle, is the following:

An improved tin protector. — Take a strip of tin four inches wide of sufficient length when encircling the tree to leave a space of about six inches. The upper edge of the tin is bent over so as to receive beneath it a piece of muslin as long as the tin and eight inches wide, to be held in place by pounding down the tin. The ends of the tin are bent in opposite directions so that they can be hooked together. Placing this around the tree with the cloth upward, the cloth is to be firmly bound to the tree by a strong cord. This method is shown in the accompanying illustration. In either of the above methods, the eggs which will be deposited in large numbers below the obstruction may be easily killed by brushing them with kerosene oil, without injury to the tree, unless an excessive quantity (a very little is needed) should be used.



the Canker-worm moth.

Killing the larvæ. — When, as in the inquiry above made, the moths have not been prevented from ascending the tree and depositing their eggs, and the caterpillars have hatched out and are rapidly destroying the foliage, then there are two good methods for their destruction which may be resorted to.

Spread a thin covering of straw under the tree as far as the branches extend, and set fire to it, at the same time jarring the tree, and as the caterpillars drop by their threads, sweep them down with a pole into the fire.

Apply Paris green in water to the trees with a force-pump, in the proportions and manner probably known to every orchardist. It may be used with perfect safety upon apple-trees so early in the season as the time during which the canker-worm prevails.

A Gooseberry Fruit-worm.

A gentleman from Delhi, N. Y., writes:

I find my gooseberries dropping badly, and have experienced the same trouble for the two years past. Upon examination for the cause, I find that nearly every berry contains a small white worm between the skin and the pulp, which sometimes has worked its way into a seed. I send some of the fruit picked up from under the bushes, and think that you will find the worm in each. The worms are not more than one-eighth of an inch in length. Can you suggest a remedy for next year, as I presume the work is done for this season?

A portion only of the gooseberries sent contained the "worm"—those which were discolored and shriveled. In the others, although each bore a scar as if an egg had been deposited, no living thing could be found.

The depredator is the larva of a lepidopterous insect — a small moth, and in all probability that described by Dr. Packard as *Pempelia grossulariæ*, and more lately known as *Dakruma convolutella* (Hübn.). At this stage of growth, it is impossible to identify positively the larva from the description published of the adult form. Later, if it be found that when the interior of the berry has been consumed, the larva passes into an adjoining one through a silken tube with which it connects the two, then scarcely a doubt will remain of its being the above-named species which was first detected by Dr. Fitch, in the State of New York, about the year 1855. Its natural history was worked out by Mr. Saunders, of London, Ontario, ten years later, and from material furnished by him, it was described and named by Dr. Packard, in his *Guide to the Study of Insects.*

Mr. Saunders states that the moth appears abroad in the month of April, and is ready to deposit its eggs as soon as the fruit is well formed. The larva hatches and usually completes its growth about the middle of June, when it lowers itself to the ground, and constructs its cocoon among the leaves or in the superficial soil. Its pupation continues through the winter, the moth making its appearance in the early spring, as above stated.

If care be taken to pick from the bushes all the prematurely ripening and shriveled fruit, and all that drops to the ground, this insect need not prove a serious pest. One caterpillar allowed to mature, may the following season be the progenitor of fifty or more depredators upon the same bushes.

Dusting the bushes with fresh air-slacked lime about the time when the eggs are deposited — the last of April or first of May — is recommended, and has been thought to be attended with beneficial results in keeping away the moth.

Insects and Fungus on Quinces.

A package of nearly half-grown quinces was received from Union Springs, N. Y., under date of July 27, with the following inquiry of the cause of their appearance and condition :

I have just received from C. E. Cook, of South Byron, N. Y.— a large orchardist, specimens of quinces containing an insect, and singularly infested with a rusty fungus, which I forward to you for examination. Mr. C. thinks it is all caused by the insect inside the fruit. I am informed that much of the fruit is thus attacked, and it is feared that the difficulty may become a formidable one. What is the insect, and is there any remedy ?

The Quince curculio and the Apple-worm.— The quinces contained two insects burrowing within them, viz., the larva of the quince curculio, *Conotrachelus crataegi* Walsh, and the larva of the codling-moth, *Carpocapsa pomonella* (Linn.). The former was the most numerous, as in some of the quinces examined, four examples of it were found. They are easily to be distinguished from the apple-worm, as they are without feet. Walsh has described them as of "an average length when full-grown, of 0.32 of an inch, four and one-half times as long as wide, straight, opaque-whitish with a narrow, dusky dorsal line generally obsolete on the thorax, and a few very short hairs; distinct lateral tubercles on all the joints; head rufous, mandibles black, except at base, and distinctly two-teethed at tip."

The beetle is figured in the Third Missouri Report, as bearing only a family resemblance to the plum-weevil, *Conotrachelus nenuphar* (Herbst), being larger, with a longer beak or snout, and a body which is broadest across the base of the wing-covers.

Food-habits of the Quince curculio. — It was first found feeding upon the fruit of the black thorn, *Crataegus tomentosa*, and from this food-plant its specific name was taken. In the Western States it occurs more frequently in this fruit, but in the east it more commonly infests the quince. Instead of the crescent cut characteristic of the plum-weevil, it simply makes a puncture for the reception of its egg. Professor Riley states that the larvæ work, for the most part, near the surface, and do not enter the heart of the quince, but in those examined by me, they had penetrated quite to the interior and were feeding upon the seeds.

Its transformations. — After about a month's feeding, the larvæ desert the fruit and burrow into the ground, where they remain unchanged from the larval state throughout the winter and until early in May, when they transform to pupæ and shortly after that to the perfect insects.

Its injuries. — This insect has been known to prove very destructive

to quinces. Dr. Trimble records an instance in which, in the latter part of October, five or six hundred of the larvæ were taken from the bottoms of two barrels of quinces gathered but four days before. In an orchard, in New Jersey, in 1870, of nearly three hundred trees, scarcely a single quince could be found free from the attack of the insect. The injury was estimated at about $800.

Remedies. — The remedies against this insect are, first, the jarring method, which has proved so successful with the plum weevil, for the quince weevil falls quite as readily at a sudden jar. The proper time for employing this remedy may be found by experiment, during the months of June, July and August. Second, picking the infested fruit and destroying it. The presence of the larvæ within the fruit may usually be discovered by the black grains of its excrements attached to its surface. These rejecta are easily discernible when held in place by a fibrous fungus growth which is often associated with the insect attack. Mr. Cook informs me that the infested fruit, unlike that attacked by the apple-worm, remains firmly attached to the tree. Its collection, therefore, involves more labor than the simple gathering of the fallen fruit.

The apple-worms in the quinces. — The apple-worms were not as numerous as the curculio larvæ in the fruit sent for examination, and in no case did I discover more than one in a quince. They displayed a greater readiness, even when apparently not mature, to leave the fruit in the box in which it had been sent to me, than the other larvæ. Possibly even the smaller ones may have been mature, and all may have been seeking retreats for their pupal change.

A fungus attack. — All of the fruit received was also infested with a fungus. Some of the quinces had almost their entire surface covered with it, and its yellow growth extending quite a little distance into the fruit. The fungus has been described and named by Prof. C. H. Peck, N. Y. State Botanist, as *Ræstelia aurantiaca* — the specific name having reference to the rich golden color of its spores. Upon inquiring of Prof. Peck if the fungus was peculiar to the quince, and to what extent it had been observed to be associated with insect attack, he replied: "It occurs also on unripe fruit of *Amelanchier Canadensis* and of species of *Cratægus*. I do not think that it is always or necessarily accompanied by an insect attack, although of two specimens of quinces recently received from Rochester, and bearing the fungus, both had larvæ in them. In the Amelanchier fruit, I know that the fungus sometimes, at least, works alone." [See also *the Country Gentleman*, for Dec. 17, 1885, p. 1016.]

In answer to inquiries made of Mr. Cook of this fungus attack, the following reply was returned, under date of August 3d:

I send by mail, another package of the infested fruit, as desired.

In reply to your questions: 1. The fungus was first noticed this year. 2. I think that the fungus is found without the insect burrows. 3. The fruit does not fall when infested, but adheres firmly to the tree. 4. I find them in great numbers in all stages of infection. I have several hundred trees bearing, from which I could pick several bushels of diseased fruit. 5. I send inclosed several affected twigs, independent of fruit. You may observe that it does not affect the foliage, there being even perfect leaves in the fungus growth. It is quite serious, as it frequently continues until all the foliage is almost entirely ruined."

The quince twigs sent by Mr. Cook were affected by the same fungus that had attacked the fruit, in some examples showing as a thick irregular swelling upon one side of a twig, and in others completely surrounding it for an extent usually of about an inch. The larvæ had also attacked these fungus swellings, and had burrowed them with their channels, disclosing their presence and their operations by their excrementa adhering to the surface.

A fungus-feeding fly. — A large number of minute larvæ of some species of fly were associated with the fungus, feeding upon the orange-colored spores. Their maximum length was about one-tenth of an inch. They were pointed at both ends, but a little more acutely at the head. Their color was an orange nearly as bright as their food. Some had already transformed to the pupal stage, and a few flies which escaped from the box when it was first opened, were in all probability, the newly emerged insects. None of them were secured for examination. The species has probably not been named, for of the number of Diptera which are known as spore-feeders, but few have received study.

Remedy for the fungus.— The only means, so far as we know, for preventing the spread of this fungus, is to remove and destroy by burning or otherwise, every twig or quince giving indication of the attack. It is possible that dusting the tree with flowers of sulphur might be of service in arresting the disease.

The Plum Weevil Attacking Apples.

Apples bearing the distinctive crescent mark of *Conotrachelus nenuphar* and quite badly scarred with them, were received June 26, 1882, from Mr. H. J. Foster, of East Palmyra, N. Y. The fruit was shriveled and discolored on one side, apparently from several contiguous punctures of the weevil made for the purpose of feeding. Upon cutting into the apples, the young larvæ of the weevil were found.

On making inquiry of Mr. Foster if the attack of the plum curculio upon the apples in his vicinity might not be the result of the scarcity of their natural food, he informed me that there were very few plum

trees in the neighborhood, and that most of the farmers were compelled to purchase plums for their family use, from a locality where they were abundant, on "the ridge" or near Lake Ontario ten miles to the northward. The curculio attack had been increasing for several years, and was quite serious the preceding year. Almost every farm of one hundred acres had from five to twenty acres of apple orchard, kept in permanent pasture, yet but little fruit could survive the combined attacks of the codling-moth, the canker-worm, the tent-caterpillar, the curculio, et cet., unless stock was kept in the orchards to feed the grass closely and pick up the fallen fruit.

The earliest attacked apples, fell to the ground with the contained curculio larvæ. The later ones, it was thought, remained upon the trees.

Upon the 8th of July, Prof. Charles H. Peck, sent to me from Petersburg, Rensselaer county, N. Y., examples of the plum weevil, *Conotrachelus nenuphar*, with specimens of the apples in which he found it ovipositing. In some cases, it had oviposited in nearly all the apples upon a tree, causing many of them to fall to the ground.

Phytonomus punctatus Feeding on Beans.

Examples of this beetle were brought to me on July 2d, by Mr. J. F. Rose, of South Byron, Genesee Co., N. Y., which had been given to him by a farmer in that town with the statement that they were feeding in large numbers, upon the leaves of some field beans, and were rapidly destroying the crop. Mr. Rose knew the beetles to be abundant in localities in the town, and that they had been quite destructive to clover, for during the month of June of last year (1883), he had seen in a clover field that had been turned under for fertilizing, the larvæ so numerous on the surface of the ground the morning after the plowing that he was able to count fifty within the area of a square foot.

As the beetle had not been recorded as feeding upon beans, it was desirable that this first report of a new food-plant should be verified, before accepting it; yet as the clover and the bean both belong to the *Leguminosæ*, it did not seem improbable that with clover not convenient of access, the insect might transfer itself to some other genus of the order.

In compliance with the request made, Mr. Rose, upon his return home visited the field in which the beetles were reported as eating the bean leaves, and found them actively engaged in the work. Under date of July 14th, he wrote as follows :

I send you by this mail specimens of the beans eaten by the clover-leaf beetle together with some of the beetles taken from the beans. Mr.

White, from whose farm they were taken, as were also those handed to you in Albany, had been over the field and Paris-greened it as he would have done for potatoes. He had found as many as twenty-five beetles upon a single hill, and he thinks had he not used the Paris green, not a leaf would have been left. The poison did its work effectually and at this time but few of the beetles are to be found. The bean field was adjoining a field of clover which was plowed under, and the beetles did not show themselves on the beans until after the plowing. Many other fields of beans are reported as infested, although the one of Mr. White is the only one that I have visited.

The plants sent to me gave evidence of the possible injuries of the weevil when its attack is made in force, for almost every leaf had been entirely consumed. Much of the feeding had in all probability been done by the larvæ.

Wishing to see the method of eating in the beetles received, some fresh leaves of bean and some pods procured in the market were given them. They declined to eat the leaves, even when confined with them alone for several days, but they fed greedily upon the pods, excavating holes in different portions, of perhaps a tenth of an inch in diameter.

The "Frenching" of Corn.

A correspondent from Rock Hall, Md., sends a specimen of what, in his vicinity, is known as "frenchy corn," and asks if it is the result of an insect attack, or of conditions existing in the soil. It sometimes prevails to such an extent as to destroy an entire crop.

What is understood by "frenchy."— The term "frenchy" is one used in many localities in the Southern States in quite a general way, and is indifferently applied to diseases (aggravated form of measles, small-pox and other contagions), to various insect injuries to vegetation, and to diseased conditions of animal or vegetable life not understood. It is, however, more frequently used in connection with corn than any other plant. According to newspaper reports, thousands of acres of corn are annually destroyed in the Southern States through "frenching."

"*Frenching*" *resulting from insect attack.*— The young corn-plants sent to me, having a growth of two feet in height, had lost their tap-root, and showed clearly in their slenderness and other conditions, an impaired growth. Throughout their entire length were numerous punctures, many of which were of the size and shape of pin-holes, while others were larger and of an oval form, and had evidently increased in size and changed in form through the process of growth of the leaves. A careful examination left no room for doubt that these punctures had been made in the unfolded leaves of the plant by the beak of one of the snout beetles — *Curculionidæ*.

The insect probably Sphenophorus sculptilis.— The locality from which the material was received rendered it highly probable that the species was the sculptured corn-curculio, *Sphenophorus sculptilis* Uhler.*

This pernicious beetle extends over a large portion of the United States, occurring in Georgia, Kansas, Missouri, Illinois, and some of the Eastern States. It is particularly injurious, at times, in New York. It is of a small size, black, about three-tenths of an inch long, subcylindrical or a long-oval, its wing-covers marked with rows of punctures, its strongly curved beak of the thickness of a stout horse-hair and about one-third the length of the body. In the month of June the beetles may be found just beneath the surface of the ground, with their beak thrust into the young stalks from which they are drawing the sap. Through this method of attack the little holes above mentioned are made, and the growth of the plant arrested.

The attack and how to prevent it.— It is probable that the eggs of the beetle are deposited in the holes made in the stalk by its beak. The larva upon hatching from the egg, burrows downward and destroys the tap-root. When full-grown, it changes to the pupa state within the lower portion of the stalk. It is thought that it transforms to the perfect state — the beetle, during the autumn, hibernating in this stage, and coming abroad the following May or June to deposit its eggs. When the attack of this insect is first noticed, if sand is well moistened with kerosene oil, and a small handful distributed among the young blades of corn in a hill, as the oil is carried into the soil by the rain, it should kill the beetles engaged in their depredations. The same dressing applied earlier may be more effectual by preventing, through its odor, the deposit of the eggs. If only a few hills show the attack, the ground might be drawn away by hand from the stalks, and the beetles taken from them and destroyed.

The Bed-Bug Infesting a Library.

It is not very often that this insect occurs under the conditions mentioned in the following communication — among books and papers — where it would be so difficult to destroy it:

Will you tell us something about the bed-bug, what its habits are, when it "spawns," what it eats, how long it lives, and if it ever dies? I ask because I have moved into a house that I find was already occupied by several colonies of the pest. The room in which I have my library has the most. They are in my files of papers and periodicals. They seem to grow fatter every day, but for the life of me, I cannot tell what they live on. The beds and furniture are poisoned with cor-

* See First Report on the Injurious and other Insects of the State of New York, 1882, pp. 253–263.

rosive sublimate, and are free from them. Can it be that they live on the paste on the wall paper? As for remedies, or rather exterminators, I have used two — the sublimate and red pepper. The latter, I have sifted through my papers and books, and wherever I could get it; but instead of driving them off, they seem to fatten on it; it is a sort of condiment that helps them to relish their dinner the better. If you can tell me what to do, and answer the first question also, you will do me a great favor. I would move to another house, but there is not a vacant one in the place.

The bed-bug is generally believed to be a native of America, and its prevalence in Europe to have resulted from its introduction into that country in the wood imported from America for the rebuilding of London after the great fire of 1666. This, however, must be an error, for although it was not common in England, "it was well known in some parts of Europe before that time, and is mentioned by Dioscorides." An old writer records it in Europe as early as the year 1503, and there is reason to believe that it was known to Pliny and Aristotle. It was first described and named by Linnæus as *Cimex lectularius* — its specific name denoting its pertaining to the bed. At present, it is known as *Acanthia lectularia*.

I am unable to find a full statement of its natural history. It has been treated of at considerable length by some of the old European writers to whose papers I have not access. Unfortunately our modern authors, in their references to the unsavory subject, dismiss it with a few cursory remarks and the statement "that its habits are too well known to call for further notice." There are, therefore, several points in its domestic economy of which we are still in ignorance.

The eggs are deposited, it is said, in March and April. They are of an oval form, white, and open by a little lid to give forth the occupant. A period of eleven weeks, under ordinary circumstances, carries them to their maturity. Where they can obtain the amount of food needed for their development, in an unoccupied apartment, is a question that cannot be satisfactorily answered. It is possible that in rooms where the walls are damp, the moistened paste of the wall-paper might serve them for nutriment, for it must be remembered that their food is taken by suction through a tube, and not by means of biting jaws. As quite a number of the Hemiptera are known, when pressed by hunger, to prey upon one another, it is not improbable that the young of this species may find it convenient to expedite the death of their aged and infirm parents. And possibly, they may feed upon the juices of flies and other insects, for they are known not to confine themselves entirely to the human species, but to infest, occasionally, chicken-coops, and also, it is stated, dove-cotes. When they have reached maturity, they are

capable of living a long time without food. De Geer, a distinguished Swedish naturalist of the last century, kept some specimens alive in a sealed bottle for more than a year without food.

Probably the best method that could be adopted by the inquirer to free his library and other apartments from so serious an invasion of this pest, would be to fumigate with brimstone. Houses which after standing long unoccupied have been found swarming with the bugs, have been effectually freed from them by this means. Place in the center of the room a dish containing about four ounces of brimstone, within a larger vessel, so that the possible overflowing of the burning mass may not injure the carpet or set fire to the floor. After removing from the room all such metallic surfaces as might be affected by the fumes, close every aperture, even the key-holes, and set fire to the brimstone. When four or five hours have elapsed, the room may be entered and the windows opened for a thorough airing.

Psylla buxi upon Box, at West Farms, N. Y.

Mr. James Angus, of West Farms, N. Y., sent to me, under date of May 23d, a small insect upon box, *Buxus sempervirens*, which according to his statement, entirely covers the plants at this season of the year. They secrete a white, floculent matter, and cover the leaves with a thick honey-dew. Later in the year their gummy exuviæ greatly mar the beauty of the plant. The only remedy thus far found against them has been to beat the plants violently with a broom and then to rub the dislodged insects into the ground. This was done several times during the season.

The insects were found to be *Psyllidæ* — probably of the genus *Psylla*, but as they were at this time in their pupal stage, no determination could be made. They averaged one-tenth of an inch long, of an apple-green color, head broad, nearly as broad as the thorax; thorax and abdomen about equal in length and breadth; antennæ apparently four-jointed, the last joint black and the others black at the tip.

They were confined in a small jar with the leaves of the box, and on the 29th of May the first imago was disclosed. Upon submitting specimens to Prof. Uhler for determination, he kindly returned the following reply :

I have carefully compared your specimens of *Psylla* with *Ps. buxi*, of Europe, in my collection, and I fail to discover any differences. As the wings of one specimen are clouded, I take it for granted that this one is immature; the others have transparent wings. *P. buxi* Linn., is described in *Syst. Nat.*, ii, p. 738; *Fabr. Spec. Ins.*, ii, p. 391; *Reaum. Ins.* iii, pl. 19, figs. 1–14; *Foerster, Verhandl. Nat. Verein. Preuss. Rheinl.*, 1848, iii, p. 71, No. 3. It is common in England and Germany.

This occurrence of the species at West Farms is of no little interest, as it had never before been reported in the United States.

In the report of the Commissioner of Agriculture for the year 1884, at page 410, Prof. Riley has published a brief notice of this discovery.

An Aphis Attack on Roots of Peach-trees.

Notice of an aphis attack upon the roots of seedling peaches has been communicated to me by Mr. Lorin Blodget, of Philadelphia, Pa. The injury to the trees was first noticed in the year 1881, but its cause remained unknown until the early part of July, 1884, when upon pulling up a seedling peach-tree just beginning to wilt, its stem for an inch below the surface was found to be crowded with dark colored aphids: numbers of ants were associated with them. In following up this discovery — of a hundred trees examined, one-half at least were found so seriously injured that they were past recovery and were accordingly destroyed. It was doubtful if any of the remainder could survive the attack. In one instance, some aphids were discovered above ground, upon the succulent shoots about a foot long, of a three-year-old tree, which were densely crowded with them, presenting "a singular sight, with their black, shining backs, covered with ants and with large flies often upon them." During forty years' growth of seedling peaches, no injury of this character had been observed before this attack.

Some examples of the insect sent to me, were dead when received and in otherwise poor condition. They were wingless, entirely black, although said when living to be brownish-black. The species evidently belonged to the genus *Myzus*, and probably (the material being too poor for positive determination) to *persicæ* of Sulzer. A letter to Mr. Blodget expressing this belief, was subsequently handed by him for publication to the *Gardener's Monthly and Horticulturist*, for September, 1884 (xxvi, p. 271–2).

Mr. Blodget claims for this species a remarkable power of endurance of cold,— that it lives and thrives all winter. So late as the 25th of October, after a severe frost, a shoot of a peach-tree cut off close to the ground, was entirely black for six inches of its length with the insect in lively condition. This was sent to the Department of Agriculture, at Washington, for examination. Answer was returned that it had been referred to Professor Riley, and the aphis pronounced by him to be *Myzus cerasi* of Fabricus, which he had long known as injurious to peach-trees, especially to young ones in the nursery, by working on the roots.

An earlier notice of the operations of what was probably the same insect upon the roots of peach-trees, was given by Mr. Glover on page 37

in his Report on Homoptera contained in the Report of the Commissioner of Agriculture for the year 1876, pp. 24–46. It is this:

Colonel Wilkins, of Riverside, near Chestertown, Md., a very extensive peach grower, last spring wrote to the Department of Agriculture that an aphis or plant-louse similar to those infesting his peach-tree leaves was at work on the roots also, and was killing them by hundreds. Professor P. R. Uhler, of the Peabody library in Baltimore, to whom Colonel Wilkins applied, visited the infested peach orchards, and found the statement to be perfectly correct, and that an underground aphis or plant-louse, not differing from those on the leaves, was doing immense injury to the young trees by sucking out the sap. Professor Uhler also stated that both insects are different from the *Aphis persicæ* above mentioned, and probably is a new species, closely allied to, if not identical with, the *Aphis chrysanthemi* of Europe. The insects on both roots and leaves were about 0.08 of an inch in length, with the contour of a broad Florence flask, of a blackish-brown color, and the two varieties could not be distinguished from each other when placed side by side.

Dr. J. C. Neal, in his Report to the Entomologist of the Department of Agriculture at Washington, of insect injuries observed by him in Florida, in 1882, mentions the occurrence of "lice on roots of the peach," which may also have been identical with the above (*Bulletin* No. I, *U. S. Dept. Agricul.—Divis. of Entomol.*, 1883, p. 36).

In some correspondence with Prof. Riley in relation to this species, he pronounces it identical with forms that he had received in past years from others, and especially in April, 1875, from E. Wilkins, of Chestertown, Md. It had been very destructive for years on the Atlantic seaboard, and in notices of it published and in replies to correspondents, he had generally referred it, with doubt, to *A.* (*Myzus*) *persicæ* Sulzer; but in consideration of the differences in the descriptions of this species by Boyer, Sulzer and Kaltenbach, and the general characters being so near to *Myzus cerasi* (Fabr.), he had recently referred it rather to this latter species.

Only the wingless form was sent to me by Mr. Blodget. I was informed that the winged form was observed by him to be quite abundant during some warm weather in the latter part of November, but he was unable to comply with my request for some examples, as a severe gale, followed by extreme cold weather, had driven them all away or destroyed them.

Whether this should be regarded as a distinct species, or whether it shall prove to be only the root-inhabiting form of *Myzus persicæ*, can only be determined with ample material at hand for study, and careful comparison with the various descriptions of the allied species. The latter view is apparently held by Professor Uhler, who in his late very valuable contribution to the *Standard Natural History*, published by Cassino & Co., has written:

In many species of the true plant-lice, it is now well established that there are two types of the same insect, the one inhabiting the roots, and living there during the colder part of the year unwinged — the other inhabiting the leaves and twigs throughout the spring and summer. This is notably the case with a small black aphis which injures, and even destroys, the peach-trees of eastern Maryland, Delaware and New Jersey.

Remedial measures. — The following measures, substantially, were recommended by me, to Mr. Blodget, as promising success in arresting the attack of this root-aphis:

Remove a portion of the surface soil from above the roots of the young trees, and apply hot water of as high a temperature as experiment would show could be borne by the trees without injuring them. This should prove fatal to the aphides.

A kerosene and soap emulsion, similarly applied, could hardly fail of proving effectual, as also the Soluble Phenyle noticed in the First Report on the Insects of New York, pp. 48–50. Simply pulling up the infested seedlings and burning them, cannot be relied upon to arrest such an attack, if others are to be grown in the same ground. Numbers of the insects would be left in the soil surrounding the roots, where, after the removal of the peach roots, other food might be found affording nourishment and providing for the continuance of the species. It was formerly believed that the species of Aphides were confined to a single food-plant. Dr. Fitch was of the opinion that *A. cerasi* pertained only to the garden cherry, *Cerasus vulgaris*, and that each "of our native or wild cherry trees [five species] have plant-lice peculiar to them which seldom if ever fix themselves upon the foliage of the other kinds;" yet the *A. cerasi* (*Myzus cerasi*) has since been found upon the plum and the peach, and perhaps upon so different a food-plant as the *Chrysanthemum*, Prof. Uhler having expressed the opinion that it may be identical with *Aphis chrysanthemi*. If then, the attack upon the seedlings be not entirely arrested by the measures above recommended, a new locality should be selected for growing them, and the ground that they had occupied treated with a liberal application of fresh gas-lime, which, when washed in by rains, could be relied upon for killing the Aphides at the moderate depth at which they would occur.

When the roots of larger trees, which are too valuable to sacrifice, are attacked by this insect, the method might be used which was found highly successful in France for the destruction of the *Phylloxera* upon the roots of grapevines, viz., the introduction of bisulphide of carbon into the soil by pouring a small quantity of it into a hole two or three feet in depth, made in the ground by a pointed bar, confining it therein by packing the ground over it so that in its gradual decomposition it

may permeate the soil, and with its poisonous vapor kill the Aphis (see 1st *Report Insects of New York*, page 47). The "nether-inserter" of Dr. Barnard, noticed in a following page, could advantageously be used for the conveyance of this powerful insecticide into the ground.

As superior to the above, recommendation has been made by M. Dumas, Permanent Secretary of the Academy of Science of France, for the arrest of the grape Phylloxera, of the sulpho-carbonates of potassium and sodium, and of barium. They would be equally serviceable against all root-inhabiting aphides.

The sulpho-carbonate of barium decomposes under the influence of carbonic acid, and evolves sulphuretted hydrogen and bisulphide of carbon. Placed in the ground, by its slow decomposition, it should prove a powerful insecticide.

Sulpho-carbonate of potassium, in addition to its toxic effect, has also a direct invigorating influence upon the plant.

The use of these sulpho-carbonates was suggested by the need of some substance that would evaporate less quickly than the bisulphide of carbon, and thereby infect with its vapors all the surrounding soil. They should be reduced to fine powders and spread over the surface of the ground before the heavy autumnal rains.

Pulvinaria innumerabilis upon Grapevines.

N. C. Scudder, M. D., of Rome, N. Y., in sending examples of *Pulvinaria innumerabilis* Rathvon, under date of July 20, 1884, writes: "I send specimens that I took from a grapevine in my garden. The vine was very thrifty and had an abundance of small clusters of grapes. In the latter part of June I noticed that the grapes began to wither and dry up. On searching for the cause, I found these specimens fastened to the vine, from the surface of the soil upward for about three feet, the greatest number being gathered about the enlargements, or where the vine divides into smaller branches. I searched diligently among upper branches, but found none. In all cases I found them attached *under* the loose bark. What I took to be the eggs, I found to be all alive, and when I emptied the contents of the shell into my hand they began to crawl. * * * * Since I began destroying these insects, what few grapes were left have grown and shown no signs of destruction as yet."

In acknowledging the above, in addition to the removal of the scales, recommendation was made of application at the time of the hatching and distribution of the young lice, of kerosene oil emulsified with either milk or soap, and properly diluted according to the directions given in the reports of the Entomological Division of the Department of Agriculture at Washington, and in various other entomological publications.

The young lice were hatching from the eggs at the time that the specimens were sent.

An unrecognized Apple Attack.

Under date of January 25, 1884, Secretary Harison informed me that he had been addressed by Mr. H. C. Watson, of Port Kent, N. Y., in relation to a great loss of apples in his vicinity recently. Mr. Watson had written as follows:

The apples affected, I think, exhibit no orifice, but appear on the surface round and fair. When cut across longitudinally, a circle of dark spots is revealed similar in position to those that children sometimes call "the ten commandments." Immediately upon exposure to the atmosphere a serum exudes from these spots, and generally a white worm or maggot soon appears in the serum.

Mr. Watson also stated to Mr. Harison that while almost all gardens in his village had the fruit affected in the manner above stated, yet some orchards had wholly escaped.

Under date of February 8th, Mr. Watson sent to me three of the apples showing the attack. Two of them had been cut transversely several days previously to all appearance, as the cut surfaces had partially dried, and showed the commencement of decomposition in the more moist portions. The "ten commandments" could be made out, but were not a conspicuous feature, and seemed to have no connection with the attack. Some small grains of larval excrement were scattered over the surface, but no larvæ were visible. A number of spots, small and blackish, could be seen.

Upon the fourteenth of February the cut apples were again examined, when, upon the surface of one, two larvæ of two species were discovered. The one, a white, slender larva, about one-tenth of an inch long, with its anterior end extended into an extensile point, evidently one of the Diptera, and perhaps of the genus *Ampelophila*. The egg from which it proceeded may have been deposited upon the fruit after the commencement of its decay.

The other larva was about one-twentieth of an inch long, with a large, flattened head, with strong jaws and conspicuous antennæ, with six legs as long as the width of the body, the body with a few short hairs, two longitudinal yellowish subdorsal stripes upon its posterior segments, and the last segment terminating in two short pointed processes. It evidently belonged to the Coleoptera. No explanation presents itself for its presence in the apple at this time.

Upon cutting the third apple, a number of spots of different sizes, from one-tenth of an inch downward, were observed, most of which were near the exterior. These spots contained yellowish, soft matter,

and upon following some of them, they proved to be continued within the fruit in irregular channels. They may have been caused by the burrowing of small larvæ, but no evidences of this were discovered. After the above slight examination the two halves of the apple were placed together to await other examinations, which, however, were not made.

It is not probable that either of the above larvæ were the cause of the injury to the fruit of which inquiry was made.

REMEDIES AND PREVENTIVES.

Coal Ashes for the Currant Worm.

From the New York Agricultural Experiment Station the following experiment of mulching currant bushes with coal-ashes is reported:

A plat of bushes mulched with this material in the spring, on which no insecticide application had been made, suffered less from the currant worm than an unmulched plat that had been several times treated with hellebore.

As the larva of the currant saw-fly transforms to the pupa but slightly buried beneath the surface of the ground, it would not be strange if the presence of the coal-ashes should prevent the development of the perfect insect, through either its chemical effect upon the delicate pupa or a mechanical action upon the larva in its burrowing into the soil.

A Carbolic Wash for the Peach-tree Borer.

A wash prepared from the carbolic soap of Buchan & Co. (Messrs. Kidder & Laird, 83 John street, New York, agents), appears, from the testimony given in its favor, to be an effectual preventive of the attack of the peach-tree borer, *Ægeria exitiosa*. It is prepared as follows: A five-pound can of the soap known as the "Carbolic Plant Protector," to be ordered of the agents if not purchasable at the city drug stores, is to be emptied into a barrel (when a large number of trees are to be treated), upon which two or three pailfuls of hot soft water are to be poured. Let it stand for twelve hours or more to dissolve. When it is to be used, fill the barrel with cold soft water — making about thirty gallons of the wash, which will be sufficient for about three thousand trees of the ordinary size.

The following statement in regard to this wash has been made by Mr. M. B. Bateham, of Painesville, O., in the *Country Gentlemen* for August 24, 1876 (page 535):

Ten years ago, having thirty acres of young peach orchard, I found as others have done, that fighting the borers by semi-annual examinations of each tree, and digging out the worms with pen-knife or wire, was going to be a serious task. I then procured a lot of roofing-paper, of which coal-tar was an ingredient; cut it into strips six inches wide, and fastened these tightly around the base of each tree with a tack. This method was in the main successful, and much less expensive than the hand-killing. But a couple of years after, I received from a firm in New York a small box of "Buchan's Carbolic Soap," which was at that time extensively advertised as a remedy for plant-lice and other kinds of insects that annoy horticulturists, and I was requested to experiment with it according to hints and directions furnished.

I tried this soap on aphis, scale-lice and various other small insects, with good success, and was especially pleased *to find it a complete protection against the peach-borer*, which was of the most importance to me. The first season I applied it twice; first about the middle of June, as soon as I began to see any Ægeria moths flitting about, and again about a month later, as I had noticed that the insects continued to appear and lay their eggs for a month or longer time. But since the first season I have only used one application of the wash, about the first of July, each season, and not more than from three to five per cent of my trees have been affected with borers, and those not perceptibly injured by them. In a locality where peach orchards are plenty and the borers troublesome, I would recommend two applications of the wash each summer, and *I am confident it will prove completely effective* if the materials are good and the work properly done.

I have never been able to perceive the least injurious effects of this wash, even on young peach-trees, and I presume that its strength might be safely increased if thought desirable.

For aphis and bark-lice of the various kinds, I have found the carbolic wash of much service. It should not be used quite as strong when applied to the foliage of young shoots, as recommended for the borers. It is well to test the strength by wetting a few leaves with it, and noticing the next day whether they are seemingly injured by the application. If so, dilute it more before using.

I think, from repeated experiments, that the wash is as effective a preventive of the apple borers as the peach. For the old or eastern borer (*Saperda*), which works near the roots, the mode of application is the same as on peach-trees; but for the western, or flat-headed borer (*Chrysobothris*), the whole of the trunk of the tree, especially the south-west side and large limbs, if exposed to the hot sun, or where the bark is at all injured, should be washed.

Where the "Carbolic Plant Protector" cannot be conveniently obtained, a wash may be prepared with the carbolic acid to be purchased of druggists, which, according to Mr. Bateham, is equally effective with the manufactured carbolic soap.

In a gallon of common soft soap, thinned with a pailful of hot soft water, a half-pound of carbolic acid (the pure) is stirred. After it has stood for a day or longer, or until the proper union has taken place, add thirty gallons of cold soft water, making a barrel of the wash. If a less amount of the wash is needed, of course the proportionate quantities of the materials may be used. The crude carbolic acid would doubtless answer as well, but a larger quantity, perhaps double the amount, would be necessary.

Later, under date of April 15, 1880 (*Country Gentleman*, xlv, p. 246), the following somewhat stronger wash is given by Mr. Bateham, and it may be presumed to be that which continued experiments have shown to be the most effectual:

For an orchard of five hundred bearing trees, we buy a pint of crude carbolic acid, costing not over twenty-five cents (or half as much as the refined), then take a gallon of good soft soap and thin it with a gallon of hot water, stirring in the acid and letting it stand over the night or longer; then add eight gallons of cold soft water, and stir. We have then ten gallons of the liquid ready for use. Some peach growers use a little more and some a little less of the acid, but if it is much stronger than the above, it would be apt to injure the trees. The wash should be thoroughly applied with a swab or brush around the base of each tree, taking pains to have it enter all crevices.

The proper time to apply the wash is about the last of June, if the weather is hot, or the first of July. Mr. Bateham, whose long experience in the cultivation of peaches has made him familiar with the parent moth and observant of its habits, has never seen one in his locality (Painesville, Ohio, N. latitude 41°, 40′) depositing its eggs before the first of July. He finds this to be the best time to apply the wash, "as it drives off the moth by its odor, and instantly kills any eggs that may have been deposited." For the apple-tree borers he applies this same wash about the first of June.

Pyrethrum for the Cabbage Worm.

At the New York Experiment Station, a mixture of one part powdered pyrethrum with three parts of plaster or air-slacked lime, has been found quite effective in destroying *Pieris rapæ* larvæ on cabbages. It is applied with a wooden bellows manufactured for the application of powdered insecticides, by inserting the nozzle among the leaves, so that the powder is driven through the plant.

Another mixture of pyrethrum, still further diluted than the above, and therefore more economical, is one part of the powder to twenty of flour, applied with a bellows. Experiments made with this preparation, show the *P. rapæ* larvæ to have been killed in twelve hours.

Carbolic Acid for the Cabbage Worm.

As cheaper than pyrethrum powder and more quickly applied, the following application may be made: One tablespoonful of the cheapest black carbolic acid diluted in one gallon of water, applied sparingly, after heavy rains, at intervals of three or four weeks, if the caterpillars are observed. Persons who have tested the above, claim that it has given them uninjured crops of cabbage. (*Country Gentleman.*)

Road Dust for the Cabbage Worm.

A simple and costless palliative, if not a preventive of the ravages of this insect, has been found in the frequent use of dry dust. A quantity of road dust should be kept in a covered vessel near the cabbage patch in the garden, and every few days or after rains, a little of it should be sifted over each cabbage head.

Coal-oil Refuse for the Canker Worm.

Instead of the tar or printers' ink band, applied about the trunks of trees to prevent the ascent of the wingless *Anisopteryx vernata*, the residuum from kerosene oil works may be used. It is cheaper and will last twice as long as the tar or ink, not requiring renewal oftener than once in six days. It has been used with success when printers' ink has failed. (*Transactions of the Massachusetts Horticultural Society* for 1883, Part 1, p. 16.)

A Wash for the Apple-tree Borer.

The best protection from the injuries of the flat-headed apple-tree borer, *Chrysobothris femorata* Lec., so far as known at the present, is a wash made of soft soap and carbolic acid. Soft soap and lime, with a little glue dissolved to promote adherence, is also used. As this insect, unlike the round-headed borer, *Saperda candida* Fabr., formerly known as *Saperda bivittata* Say, does not confine its attack to the base of the tree, but extends into the branches, and even into the terminal twigs, as I have observed when the tree has become diseased, it is important that the soap be applied to such portions of the branches as can be reached. This coating, made in May, and again in early July and late August, will usually prevent the deposit of the eggs; but it is not well to trust alone to its efficacy. Where the insect abounds, the trees should be carefully examined for the presence of the borer, which may be detected by the excrementa or borings at the commencement of the burrow, or, when the borer has just entered, by an exuding drop of sap upon the bark at its place of entrance. A gentleman who has had

much experience with this borer in the West, gives this advice (7th Rep. Ins. Mo., p. 79): "It is best for those having trees subject to attack, to look them over every week, if possible, or every two weeks at least, from the first of June until autumn, for exudation of sap from the bark, which is a sure indication of their presence. When noticed, the borer may be removed by cleanly cutting out a small slice of bark."

The above means involve labor, but if not resorted to, apple-trees cannot be grown in localities where this borer abounds, particularly in portions of several of our Western States, where as many as a hundred of the borers have been taken from one small tree.

Saltpetre for the Striped Cucumber Beetle.

Saltpetre dissolved in water has been recommended for use against both the larva and the perfect insect of the striped cucumber beetle, *Diabrotica vittata* (Fabr.), and also for protection from cut-worms, as appears in the following paragraphs taken from agricultural journals.

To destroy bugs on squash and cucumber vines.—Dissolve a table-spoonful of saltpetre in a pailful of water, put a pint of this around each hill, shaping the earth so that it will not spread much, and the thing is done. The more saltpetre the better for vegetables, but the surer death to animal life. The bugs burrow in the earth at night but fail to rise in the morning. No danger of killing any vegetables with it; a concentrated solution applied to beans makes them grow wonderfully.

Wetting the soil around cucumbers, squashes and other *Cucurbitæ* three or four times at intervals of as many days, with a solution of saltpetre — an ounce per gallon of water — is referred to as preventive of ravages of the borer; and sprinkling the leaves with the same is suggested as useful against "the striped bug."

One year ago I had a patch of beans entirely destroyed by cut-worms. I planted it over; as soon as they came up the worms began again. I dissolved half a pound of saltpetre in three pints of water, mixed that thoroughly with one-half bushel of dry ashes, and sprinkled the ashes on the beans just as there was a shower coming up and the rain washed the ashes all off into the ground. I had no more trouble with the worms but had a good crop of beans.—[R. K., Franklin Co., Mass.

A saltpetre solution is frequently recommended to be poured about the roots of plants infested with cut-worms. It kills the pests and is a nitrogenous fertilizer.—(*New England Homestead.*)

The experiment with this material can so easily be made, that it deserves trial with several of our smaller root-insects, as for example, upon the radish, cabbage, and onion maggots, *Anthomyia raphani* Harris, *Anthomyia brassicæ* Bouché and *Phorbia cœparum* (Meigen).

Notwithstanding the statement of its efficacy against cut-worms above given, it may well be doubted whether the benefit supposed to have been derived from its use could not better be accounted for, from a cessation of the attack through the maturity and pupation of the larvæ after a second planting.

Gypsum and Kerosene for the Squash-bug.

The following application for preventing the attack of the squash bug, *Anasa tristis* (De Geer), is given: To two quarts of gypsum put one tablespoonful of kerosene oil; this sprinkled on the vines will generally answer for the season. If the bugs return repeat the operation.

The person giving the above, states: I applied it this season on several thousand hills of melons, cucumbers, etc., after the bugs had commenced operations, and have not since had a vine destroyed. I have used it for several seasons with the same result. This is safer and cheaper than Paris green.

This preventive promises to be effective against the striped cucumber bettle (*Diabrotica vittata*), and the cucumber flea-beetle (*Crepidodera cucumeris*), which in addition to the squash, injure seriously the melon and the cucumber.

Vaporized Tobacco Juice for "Thrips," etc.

The vapor from tobacco juice for killing the smaller insects that are the pests of plant-houses, has lately been employed very successfully in France, but, we believe not to any extent in this country. If its merits are what are claimed for it, it will supply a long-needed want in our conservatories and graperies. One who has tested it states: "Ever since I adopted it, it has been absolutely impossible to find a thrips in my houses; and other insects have likewise disappeared." The method of using it is thus described:

Every week, whether there are insects or not, I have a number of braziers containing burning charcoal distributed through my houses. On each brazier is placed an old sauce-pan containing about a pint of tobacco juice of about the strength of 14°. This is quickly vaporized, and the atmosphere of the houses is saturated with the nicotine-laden vapor, which becomes condensed on every thing with which it comes in contact — leaves, bulbs, flowers, shelves, etc. When the contents of the sauce-pans are reduced to the consistency of a thick syrup, about a pint of water is added to each, and the vaporization goes on as before. I consider a pint of tobacco juice sufficient for a house of about 2,000 cubic feet. The smell is not so unpleasant as that from fumigation, and the tobacco juice can be used more conveniently than the leaves. Plants, no matter of what kind, do not suffer in the least, and the most delicate flowers are not in the slightest degree affected,

but continue in bloom for their full period, without any alteration in their appearance. When the operation is completed, if the tongue is applied to a leaf, one can easily understand what has taken place from its very perceptible taste of tobacco.

The process requires to be repeated in proportion to the extent to which a house is infested. It is not to be imagined that these troublesome guests are to be quite got rid of by a single operation. A new brood may be hatched on the following day, or some may not have been reached on the first day, so that the vaporization should be frequently carried on until the insects have entirely disappeared, and after that it should be repeated every week in order to prevent a fresh invasion. (*Country Gentleman.*)

In France, the tobacco juice of the strength above stated, can be purchased of the tobacco factories at about twelve or fifteen cents (our money) a quart, by presenting a certificate that it is to be used for killing insects. The expense, at this rate, would be very trifling, being only about twenty-five cents a week for a plant-house fifty feet long by sixteen broad and ten high.

A strong infusion of tobacco leaves made by boiling, would be a substitute for the above factory juice. It might be prepared in quantity and evaporated for convenience of keeping and ready use, to the proper degree.

The "Thrips," for the killing of which the vaporized tobacco juice is recommended, is a popular name which has obtained currency among vine-growers for a small (about one-eighth of an inch long), slender, spindle-shaped, parti-colored leaf-hopper, which in its larval, pupal and perfect stages is very destructive to the foliage of grapevines. It attacks the leaves by puncturing them with its proboscis, usually upon the under side, withdrawing the sap and causing small discolored spots over their surface. The spots increase in size and number by coalescence and the growth of the insect, becoming later, large, brown blotches, which gradually extend, if the attack is severe, over the entire leaf, until it dries, appearing as if scorched by fire, dies, and falls from the vine. The fruit is dwarfed, fails to ripen, or the vine is killed, according to the abundance of the insects.

It is believed that several distinct species are usually associated in this attack, belonging to the genus *Erythroneura*, of which the principal one is that described by Dr. Harris in the year 1831, under the name of *Tettigonia vitis*, a figure of which (pronounced a poor one by Mr. Walsh*) is given in Plate 3, of *Insects Injurious to Vegetation.*

*A better one may be found in the *Practical Entomologist*, ii, p. 51, which has been copied in Packard's *Guide to the Study of Insects*, in Saunder's *Insects Injurious to Fruits*, and in other recent publications.

The Thrips proper is quite a different insect. There are a number of species, constituting the family of *Thripidæ*, the location of which, in classification, has caused much discussion. By Haliday, it was separated as a distinct order under the name of THYSANOPTERA, which has been accepted by a number of entomologists. Dr. Packard and others regard it as belonging to the HEMIPTERA, having affinities both with the *Corisidæ* and the *Mallophaga*. Their habits vary greatly, for while many of the species are certainly vegetable feeders and injurious in their operations, others are carnivorous, and are serviceable in the destruction of gall-insects,* eggs of the curculio,† the red-spider (*Tetranychus telarius*),‡ the clover-seed midge (*Cecidomyia leguminicola*) § probably the wheat-midge (*Diplosis tritici*),‖ and other insect pests.

INFUSION OF TOBACCO FOR THE ROSE-LEAF HOPPER.

An infusion of tobacco is said to be an effectual preventive of the little white leaf-hopper often so injurious to roses, the *Tettigonia rosæ* of Dr. Harris. Where the tobacco stems can be procured, place some of them in a vessel (a tin pan of the capacity of about two gallons would be convenient) and pour boiling water over them, so as to cover completely, and leave it standing over night. Dilute for using with four or five times the quantity of water and apply with a syringe or force pump, taking care to distribute it also over the underside of the leaves. The application, like most other liquid applications to leaves for the prevention of insect injuries, should be made in the evening or early in the morning. It should first be applied early in the season before the injuries are very apparent, and as soon as the young larvæ, looking like little white specks, can be discovered upon the underside of the leaves. As often as may be needed, in order to check the attack, the showering with the infusion should be repeated.

INFUSION OF TOBACCO FOR APHIDES ON HOUSE-PLANTS.

A similar infusion to the above is recommended by Mr. John G. Barker, at a recent meeting of the Massachusetts State Horticultural Society, for killing the "green fly" (Aphis) that infests house-plants. It is made by filling a pail with stems and pouring on them all the water the pail will hold. This should stand for twenty-four hours and used in the proportion of half a pint to a pail of water [seemingly a very

* Riley: 6th *Report Insects of Missouri*, p. 50, and 5th do., p. 118.
† Id.: 2d Report, p. 6; 3d Report, p. 29 (the species not named).
‡ Pergande, in *Psyche*, iii, 1882, p. 381.
§ Id., ib.
‖ Walsh, in *Proceed. Entomolog. Soc. Phila.*, iii, 1864, p. 611.

weak infusion]. The plants should be turned bottom up, placing the left hand over the top of the pot to prevent accident, and then plunging it in the infusion once or twice until the insects drop off. Some of the liquid should always be kept on hand and used on the first appearance of the aphis. After using, the plant must be rinsed in clean water of the same temperature as the room. A florist in Philadelphia kept his plants free from injury in this way without fumigating.

Kerosene Oil for Scale-Insects on House-Plants.

Mr. Barker had found the scale-insects so common on oleanders (probably *Aspidiotus nerii* and *Lecanium hesperidum*) and other thick-leaved plants, more difficult to be destroyed. These may be washed with whale-oil soap and water. A sponge dipped in a little sweet or kerosene oil, and wiped up the stem and under the leaves occasionally, will keep off the scale effectually. This had been applied to plants which had been neglected and became very dirty, using the kerosene so freely that there were misgivings of the result, but with only beneficial effects.

Sulphur for Cabbage Aphis.

A correspondent of the *Home Farm*, states that after having contended for several years with cabbage-worms and lice, and using nearly all the various remedies proposed for them, he has at last succeeded in ridding his cabbages from attack, by a means which he thinks is new, and which he hastens to give to the public. It is simply to sprinkle a little sulphur on the heads of the cabbage when the presence of the insect is noticed. He had applied it three times during the season and "deliverance came every time, at once." The sulphur caused the leaves to curl slightly and to discolor a little, where it was distributed the thickest, but it did not check the growth nor otherwise injure the plants.

Grape Bagging to Protect from Insect Attack.

The utility of bagging grapes, is a question not yet settled by grape-growers. Perhaps no general rule can be established, under the greatly varying conditions of soil, culture and exposure of different localities. If the fruit is liable to insect injury, it offers a means of entire protection, at a cost, it is believed, more than repaid, by the attendant benefits of protection from rot, finer color, richer bloom, larger size, etc.

The principal insect attacks which it would prevent are the following named: The grape-seed midge, *Isosoma vitis* Saunders — a small hymenopterous insect which lays its eggs upon the grape during the

month of July, the larva from which burrows into the fruit to feed upon the seed, and causes the grape to shrivel and dry. The grape-berry moth, *Eudemis botrana* (Schiff.), which deposits its eggs in June, the larvæ from which destroy the grapes in July by feeding within them and binding them together with patches of their webs and excrementa. The grape curculio, *Craponius inæqualis* (Say) —a small snout-beetle which punctures the fruit for the deposit of its eggs, causing its premature ripening and dropping to the ground. Several species of the larger Hymenoptera, as the honey-bee, wasps and hornets, feed upon the ripening fruit.

The method of bagging, and the cost of the bags is told by a correspondent of the New York *Tribune:*

Our practice has been to bag very early after the blossom falls, which protects the fruit from all destroying depredators and influences, one only excepted, which is cracking when rain-storms last several days or a week; but such storms seldom occur when grapes are ripening. The bag is torn down just far enough on either side to lap the two ends over the branch above the cluster and a pin put through on the under side of the limb at each corner, being careful to draw the bag over the torn ends to exclude water. The lowest corner should be pierced with the small blade of a pocket-knife for drainage. This is better than a round hole made with an awl, as it closes and excludes the spores of fungi and small insects. We order two-pound bags for two-thirds of the number needed, for single clusters; for the other third, four-pound bags to be used over two clusters occurring together. They can be ordered from any paper warehouse as cheaply as from the factory. Two-pound Manilla bags cost $1.80 per 1,000; two-pound imitation Manilla bags, $1.50 per 1,000; and 10 to 15 per cent advance on each of the larger sizes. By counting the clusters intended to be bagged on an average vine, the approximate number needed can be readily ascertained.

A Bottle Trap for various Garden Insects.

Charles Downing mentions the following as an effectual trap for all sorts of garden insects. Fill wide-mouthed bottles half full of a mixture of water, vinegar and molasses, and suspend them among the trees. In a short time they will be full of insects, and must then be emptied and the liquid renewed. An acquaintance of his captured in this way, more than three bushels of insects in his garden in a season, and preserved it almost entirely free from their ravages.—J. W. Manning, in *Trans. Mass. Horticultural Soc.* for 1883, p. 14.

Poultry in Orchards.

The presence of large numbers of chickens, turkeys and ducks in orchards and vineyards seems to be the most effectual means yet dis-

covered for combating the number of insect pests which are taxing the ingenuity and perseverance of orchardists and vineyardists. While these fowls will not undoubtedly keep vines and trees entirely free from pests, they render a vast amount of assistance in that direction. They are proving especially valuable in case of invasion of grasshoppers. Indeed, where this pest has not appeared in overwhelming numbers, fowls are the most effective remedy yet discovered for their destruction. Thousands of dollars have been saved to the fruit and vine-growers of this county the present season by the keeping of fowls in their orchards and vineyards. * * * * Ducks have not been used here much for this purpose, but are said to do very satisfactory work. They have the most insatiable appetites for grasshoppers of any of the domestic fowls. The raising of ducks in itself is very profitable. Fruit culture and poultry raising seem destined to become inseparable industries in this country. (*Pacific Rural Press.*)

Insecticidal Properties of some of the Compositæ.

Prof. F. G. Sanborn has written me as follows:

"I will here call your attention to the fact that several other of the *Compositæ* besides those that you have mentioned, notably, *Leucanthemum vulgare* (the ox-eye daisy) and *Maruta cotula* (the common Mayweed) have proved very useful insecticides and were continually recommended by me when acting entomologist to the Massachusetts State Board of Agriculture from 1858 to 1869, inclusive. They have been used in powder, also in tea made from the flowers without pulverizing, and with excellent effect. A strong tea made from the grocer's 'Cayenne pepper' has been applied to plants infested with mandibulate insects [furnished with mandibles for biting], with good results, and has also been used as a protection from carpet eating insects."

A New Instrument for use against Root-Insects.

An instrument has lately been devised by Dr. W. S. Barnard by which those insecticides which are dangerous to plants, such as kerosene, cyanide of potassium [KCN], and bisulphide of carbon [CS_2], might be used with safety to the plants and the destruction of the insects in the ground. These substances have usually been applied on or just beneath the surface of the ground, either among or above the roots, but killing them when used in strength when coming in contact with them. When applied in volatile form they are less injurious. The instrument for conveying the insecticide beneath the roots, called a "nether-inserter," consists of a tube fitting closely around a solid shaft somewhat longer than the tube and pointed at its lower end, the tube being 15 mm. in diameter [0.6 inch] and the shaft 12 mm. [0.48 inch]. The upper end

of the tube expands like a bowl. The upper portion of the shaft is weighted with a heavy ball, so disposed that the shaft can be grasped above the ball. By partly withdrawing the shaft from the tube and then returning it with force as the lower end of the tube rests on the ground, both can be driven into the ground to any required depth. The shaft is then wholly withdrawn, and the insecticide poured into the tube, thus placing it beneath the roots without coming in contact with them, if the instrument has been properly inserted. The tube is then withdrawn, and the hole made by it filled with earth. The insecticide, being volatile, rises through the ground and becomes diffused. With this method of application it is believed that kerosene is superior to napthaline. (*Psyche*, for January–February, 1884, iv. p. 134.)

In a communication by Dr. Barnard to *Psyche* for March, 1884, it is stated that experiments made with the nether-inserter in applying petroleum for destroying phylloxera on vines near Washington have given "perfect satisfaction." "The nether-upward kerosene diffusion process is the only economically practical way in which the deep application of the undiluted forms of petroleum can be attempted with safety to the plant. By it the cheap, crude article and its lighter form, the naphthas, become most valuable agents against the pests. It applies likewise as a treatment against all other root-insects or subterranean pests, as, for example, the American blight aphid [*Schizoneura lanigera*], the hop-root Gortyna [*Gortyna immanis*], root maggots of the cabbage, etc. [*Anthomyiidæ*], the strawberry root beetles, cicadas, cutworms, white-grubs, wire-worms, nests of ants, etc. Thus it is seen to have a general application to a wide range of cases heretofore not satisfactorily treated."

Dr. Barnard claims also that the nether-inserter may also be efficiently used with many other insecticides, of which are the following: "Rhigolene, gasolene, naphtha, benzine, kerosene, crude petroleum, oil of tar, tar water, naphthaline, pyroligneous acid, soot, creosote, carbolic acid, cresylic acid, sulphurous acid, sulphocyanide of potassium, bisulphide of carbon, cyanide of potassium, pyrethrum preparations, lye solutions, tobacco decoction, chips and snuff water, gas water," and it may also be used for the application of liquid fertilizers, vapors, gases or fumes. In short it is available with any upward-acting insecticide against any underground enemies.

Naphthaline as an Insecticide.

From a paper read by Prof. C. V. Riley before the Biological Society of Washington, on December 14, 1883, it appears that naphthaline, [C_{10} H_8] was first made in 1808. Its use as a substitute for camphor

for killing museum pests, was suggested in 1840. Placed in insect boxes, it kills acari and psoci, but not other museum pests. Experiments were made with it against *Phylloxera vitifoliæ* in 1872. Fischer began experimenting with it in 1881. It is a better insecticide and cheaper in its crude form than when pure, but is more injurious to plants in that form. It has been applied to grapevines by pouring a kilogram [2.20 pounds] of it in a trench from 15 to 20 cm. [6 to 8 inches] deep near the stock of the vine and then filling the trench with earth.

At a subsequent meeting (28th of December), Dr. T. Taylor stated that rats, mice, crickets and locusts were driven away by the use of naphthaline. Earth worms were driven out of the ground and killed by placing it in the bottom of a flower-pot where they occurred. Insects infesting seeds were killed by placing it in jars with the seeds, without injury to the seeds. Moistening increases the efficacy of naphthaline (*Psyche*, for January–February, 1884, iv, pp. 133–134).

Kerosene Oil Emulsions.

In the preceding report of the Entomologist, reference was made (page 44) to an emulsion of kerosene and milk, but no directions were given for making it. The omission is here supplied. The method recommended by Mr. H. G. Hubbard, a special agent of the U. S. Department of Agriculture, seems to be the best presented. It is as follows:

Take of refined kerosene two parts, fresh, or preferably sour cow's milk, one part (percentage of oil $66\frac{2}{3}$). Mix in a pail or tub, by continuous pumping with a force-pump back into the same vessel through the flexible hose and spray nozzle. After passing once or twice through the pump the liquids unite and form a creamy emulsion, in which finely divided particles of oil can be plainly detected. Continue the pumping until the liquid curdles into a white and glistening butter, perfectly homogeneous in texture and stable. The time required for producing the butter varies with the temperature. At 60° Fahr. it will be from one-half to three-quarters of an hour; at 75°, fifteen minutes; and the process may be still more facilitated by heating the milk up to, but not past, the boiling point.

Upon standing for a day or two the milk (if sweet, has been used) will curdle, but as it simply thickens and hardens without separating from the oil, it needs only to be stirred, not churned again, to bring it back to its former smoothness. If sour milk is used no fermentation ensues, and if not exposed to the air, the butter can be kept unchanged for any length of time.

When needed for use the butter will mix readily with any proportion

of water, if first thinned with a small quantity of the liquid. In using the emulsion for killing scale-insects (perhaps the most difficult of insects to be destroyed by it), the kerosene butter should be diluted with water from twelve to sixteen times, or one pint of butter to one gallon and a half of water. Dilute only as needed for immediate use. (*Report of the Commissioner of Agriculture for the Years* 1881, 1882, pp. 113–114.)

A soap emulsion.—Dr. J. C. Neal, also a special agent of the U. S. Department of Agriculture—as the result of his experiments with various emulsions of kerosene oil, recommends very highly the following:

Four pounds of rosin soap—common bar or yellow soap, dissolved in one gallon of water, with heat. Add gradually one gallon of kerosene with constant agitation. A gelatinous compound is formed which is very stable.

A gallon of this emulsion, containing fifty per cent of kerosene, costs twenty-six cents.

Reducing the above by the addition of forty-nine gallons of water, gives one per cent of kerosene, costing a little more than half a cent per gallon.

This reduced emulsion is of a milky color and is quite permanent. Dr. Neal was satisfied that with it, thoroughly applied, *all* the cotton-worms reached by it, were killed without injury to the plants. (*Bulletin* No. 1. *U. S. Dept. Agricul.—Division of Entomology*, 1883, pp. 32, 42.)

Later, Mr. H. G. Hubbard reports that further experiments made by him with kerosene emulsions prove that various soaps can be readily made to combine with the oil, and that the soap and kerosene emulsions are as effective as those formed with milk. The use of soap materially reduces the cost, except where milk is abundant and cheap.

Common bar soap, soft soap and whale oil soap have been tried and found to be almost equally good. The following formula is one which has proved in practice useful where a moderate quantity of emulsion is required:

Kerosene	2 gallons	= 67 per cent.
Common soap or whale oil soap	½ pound,	} 33 per cent.
Water	1 gallon,	

Heat the solution of soap and add it boiling hot to the kerosene. Churn the mixture by means of force-pump and spray nozzle for five or ten minutes. The emulsion, if perfect, forms a cream, which thickens on cooling, and should adhere without oiliness to the surface of glass. Dilute before using, one part of the emulsion with nine parts of cold water.

The above formula gives three gallons of the emulsion, and makes,

when diluted, thirty gallons of wash. [*Report of the Entomologist: in Report of the Commissioner of Agriculture for* 1883, p. 152.]

The cost of the above wash, with kerosene oil at 12 cents the gallon, and yellow soap at 6 cents the pound, would be less than one cent per gallon.

The Shearer soap emulsion.—In a recent report, Miss Ormerod, Consulting Entomologist of the Royal Agricultural Society of England, presents the following recipe "for a simple and effective method of making a mineral oil solution," which was devised by Mr. Alex. Shearer, "a clever chemist as well as an able and intelligent gardener," and which, after experimenting with the emulsions as prepared in this country and elsewhere, she pronounces the best that she had met with. It has now been tried for several years, and found both safe and serviceable.

To eight parts of soft water add one part of black (soft) soap, and boil briskly for a few minutes until the soap is thoroughly dissolved. While boiling add paraffin [kerosene] or any other similar oil, and boil for a minute or two longer when the whole will be thoroughly amalgamated, and, if bottled and securely corked while warm, it will remain so and be fit for use at any time when required. For field use, the immediate application would save all need of storing. The strength of the solution depends on the amount of mineral oil in it, and it can be easily reduced to the proper power by mixing it with soft water as it is wanted for use.

The following notes are also given of the method found the most convenient for mixing the application.

Eight parts of water and one part of soft soap thoroughly amalgamated forms the lye which *takes* mineral oil, and thoroughly mixes with whatever proportion of the oil be added. As heat aids much in quickly producing thorough amalgamation of the ingredients, boil the soap and water together, and when ready, turn it into ordinary wine bottles (costing little or nothing) which have been placed in boiling water. About half fill the bottles, turn two gills of the oil in each bottle, then fill up with the boiling lye, cork at once, and store away for use.

When required for use, a bottle of the mixture is poured into a four-gallon watering pot which is filled up with soft water, and is ready for use, at a strength of one wine-glass of oil (half a gill) to one gallon of water [one part of oil to 64 of water — about $1\frac{3}{4}$ per cent of oil].

Half a gill of oil to a gallon of water is strong enough to kill Aphides and such soft insects; one gill for "thrips" [the small leaf-hoppers of the grapevine probably], and a gill and a half for scale-insects.

By bottling the mixture as above, no mistake need be made in using it of the proper strength.

MISCELLANEOUS NOTES.

Parasite of Pyrameis Atalanta.

A small parasite upon this butterfly, received from Mr. W. H. Edwards, of Coalburgh, Virginia, was identified by me as *Microgaster carinata* Packard, described in the *Proceedings Boston Soc. Nat. Hist.*, xxi, 1880, p. 25–6. Upon submitting it to Prof. Riley, it was compared with the type of *M. carinata* in his possession and found to be identical. It should, however, he stated, be regarded as a variety of his *Microgaster gelechiæ* (First Missouri Report, 1869, p. 178) obtained by him from the gall-making caterpillar of the solidago gall-moth, *Gelechia gallæsolidaginis*, from which "it differs only in the black anterior and intermediate coxæ and trochanters, and darker tarsi and tips of tibiæ — all variable characters within the same species."

The *P. Atalanta* parasite would therefore be — conforming to a later generic arrangement,— *Apanteles gelechiæ* Riley.

Prof. Packard has also described (*loc. cit.* p. 27) a second parasite from the same butterfly, as *Microgaster Atalantæ.*

A Diseased Brood of Actias Luna.

One hundred and seven eggs were deposited by a female brought to me, on June 27–8. They hatched July 9th, and all molted for the first time on July 15th. Five examples, just commencing to molt — the head withdrawn from the head-case — were placed in alcohol.

The 2d molt commenced on the 18th, with 5 individuals; on the 19th 19 molted, of which 4 were put in alcohol and 2 died; on the 20th 37 molted, and 1 died; on the 21st 7 molted and 2 died; on the 22d 2 molted and 2 died. Seventy passed their molt and seven died.

The 3d molting commenced July 23 — 3 individuals; on the 24th, 12; on the 25th, 24, and 7 had died.

After this time, the remainder were so diseased and died in such numbers, that no further record was kept. They were supplied frequently with fresh hickory leaves for food, but without avail. Several passed the 4th (the final molt), but died one after another — the last when apparently about three-fourths grown.

The indications of approaching death would be, eating sparingly, assuming a duller shade of green, and changing to a brownish color. They would be found dead the following day, black, perhaps hanging limp from a leaf or stem, and drawn out in length, the entire contents of

their body semi-fluid, so that it was difficult to remove some of the examples without breaking them and discharging the black fluid.

The disease was probably identical with that which had frequently been observed by me in attempting to rear larvæ of other species of Lepidoptera in confinement, and by other entomologists, and with that which was studied by Professor Forbes, in 1883, when a very large percentage of the caterpillars throughout the northern and eastern portions of Illinois were killed. It was found by him to be a contagious disease, resulting from the presence within the larvæ of innumerable bacteria, probably *Micrococcus bombycis*, and in no ways distinguishable from the *flacherii*, which was investigated by Pasteur with such brilliant results at the time when, as a silk-worm disease, it was inflicting an annual loss of hundreds of millions of dollars annually upon the silk industry of Europe. See Prof. Forbes' address "On a Contagious Disease of Caterpillars," delivered before the State Horticultural Society of Illinois, in December of 1883.

The same disease has also been noticed by me, as destroying *Pieris rapæ* larvæ in cabbage fields in the vicinity of Albany.

Heteropacha Rileyana *Harvey.*

Mr. G. R. Pilate, of Dayton, Ohio, sent under date of July 22d, some small larvæ of this species and also some eggs, found by him a few days previous. Not being able to rear them, in subsequently communicating with him, I learned that he had found no difficulty in breeding the species by the following method: "I use large glass candy-jars, eighteen inches high by eight wide, for my larvæ, putting in them about an inch and a half of white sand, slightly moistened, for if too wet it will kill the larvæ. For those that bury, I use three inches of sand. Upon the sand a piece of paper is placed to hold the excrement and permit of its easy removal when fresh food is supplied. Always give them Honey-locust to eat (*Gleditschia triacanthos*) and not the black locust."

Later, additional eggs were sent which had been laid the 8th of August, with the statement that "when first laid they are pure white, with the exception of the three spots on the top and sides."

Hemileuca Maia (*Drury*).

Mr. Pilate informs me that from about three hundred (eggs?) of this species, found on basket-willow (*Salix viminalis*), he had obtained about one hundred pupæ. The species appears to be an easy one to rear in confinement, for in colonies reared by me from the egg-belts, nearly all attained their perfect stage. Larvæ collected at somewhat an advanced age upon their food-plants are quite liable to have been parasitized, for

of a cluster of thirty found by me after their second molt, about one-third were subsequently destroyed by ichneumons, which proved to be *Limneria fugitiva* (Say) and an undetermined species of *Microgaster*. For details of this parasitism, see my "Biography of Hemileuca Maia" in the *Twenty-third Report on the N. Y. State Cabinet of Natural History*, 1872, pp. 146, 147, or *Entomological Contributions* [No. 1], pp. 14, 15.

The Hop Grub — Gortyna immanis (*Guen.*).

In my First Report, the reference to the "grub" attacking the root of the hop-vine (page 61), has been interpreted by an English writer as referring to the "white-grub," *Lachnosterna fusca* Frohl. — a very natural interpretation, from the well-known habits of that destructive species as a root-devourer, taken in connection with the customary limitation by our more careful writers of the term "grub" to a coleopterous larva, and often to the conspicuous and well-characterized larva of the *Scarabeidæ*.

The "hop-grub" was long supposed to be the larva of a beetle allied to the "white-grub," if not that identical species. Even so late as May of 1882, a paper was published in the Canadian Entomologist.* by Mr. Charles R. Dodge, of Washington, D. C., upon the "Hop-vine Borer," in which the feeding habits of the "larva" are correctly given, together with much valuable information of the injuries committed by it, and best method of dealing with it, but without presuming so much as to venture an opinion even as to the Order to which the insect might belong. Our first knowledge of its true character was that obtained from Professor J. H. Comstock, who, at the Annual meeting of the Entomological Society of Ontario, held at Montreal, during the meeting of the American Association for the Advancement of Science, in August of 1882, exhibited to those in attendance several examples of the insect which he had succeeded in rearing from the "hop-grub." It was a large and conspicuous moth, evidently belonging to the genus *Gortyna*, and presumably referable to the *Gortyna immanis* of Guenée.

We have no knowledge of any publication by Professor Comstock of his study of this insect. It has subsequently been carefully studied by Mr. John B. Smith, of Brooklyn, L. I., under the direction of the Entomological Division of the U. S. Department of Agriculture, who has given its life-history, together with remedies for its ravages, in *Bulletin No. 4, Division of Entomology*, 1884, pp. 34–39, figs. 2–4. The following is a summary of its history:

The egg, yellow-green, round, and of the size of a pin-head, is depos-

Canadian Entomologist, 1882, xiv, pp. 93-96.

ited upon the hop-vine as it begins to climb. It hatches in a few days and the slender, black-spotted, greenish larva produced, burrows into the vine just below the tip, soon causing the vine to cease climbing, point downward, and almost to stop growing. When the larva has attained a length of about half an inch, it emerges from the tip, drops to the ground, and enters the stem at the surface of the vine, where it feeds upward for a time. When it has grown to about an inch in length, it changes its direction and burrows downward to the base of the vine, at its junction with the old stock, and, eating its way out, completes its growth as a subterranean worker. The journey from the stem to the ground is made in the beginning of June, and before the 20th of the month. Here it eats a small hole into the side of the stem just below the surface and immediately above the old root. The hole is gradually enlarged until the vine is barely attached to the root, or, as sometimes, entirely severed from it.

By the middle or the 20th of July, the larva (two inches in length) has matured, when it transforms to the pupa state in a rude cell, close to the roots of the plant.

Mr. Smith states that the insect hibernates as a pupa, although "a few specimens of the moth appear in the autumn, but the majority appear in the spring, from the beginning to the end of May or later, according to the season. Whether the former hibernate or whether they perish, I have not been able to ascertain, though the latter seems the more likely."

My own observations, and such records of the moth as are accessible to me, indicate its late summer appearance only, and consequently, by inference, hibernation in that stage. My collections of it have been made only between August 25th and September 6th; and the examples in the collection of Mr. W. W. Hill, of Albany, bear the date of August 15 and 26. It is recorded as having been taken by Mr. O. S. Westcott, at Maywood, Ill., on August 26, September 3, 4, 10, 11, 22, 23 (*Canadian Entomologist*, viii, 1876, p. 15); by Mr. Roland Thaxter, at Newton, Mass., in August (*Psyche*, ii, 1877, p. 36); and by Mr. C. E. Worthington, at Chicago, Ill., also in August (*Canadian Entomologist*, xi, 1879, p. 69). The species does not appear in the published lists of collections of *Noctuidæ* of Messrs. Norman (at St. Catharine's and Orilla, Canada), Hill (in the Adirondack Region of New York), Devereaux (at Clyde in Western New York), Pilate (at Dayton, O.), and Prof. Snow (of Eastern Kansas).

The "Army-worm" in Western New York.

An appearance of the army-worm, in the vicinity of Clyde, N. Y.,

during the month of July, in 1883, was reported in several newspapers. Upon requesting of Mr. W. C. Devereaux that he would endeavor to ascertain what the insect was, as there was no probability of its being the true army-worm, *Leucania unipuncta* Haworth, he replied:

The worm, as you supposed, is not the *Leucania unipuncta*. Its feeding was done entirely on the foliage of swamp trees, taking a broad belt, and working on the very highest ones, consuming the entire foliage except the midribs. It showed a preference for ash and soft maple, although it fed on elms coming within its range. It has been said that it was a "measuring-worm," but no webs or tents were seen.

Mr. Devereaux was prevented from visiting the locality where the insect occurred, and was therefore unable to give any information of its true character.

The moth of the army-worm is a rather common insect in the State of New York, and is known to collectors as an annoying visitor in their "sugaring" operations; but it is seldom that the larva presents itself in injurious numbers, so as to merit the appellation of the "army-worm." It seems, however, to have made a formidable demonstration, in August of 1882, in the neighborhood of Saratoga Springs. Examples of a black caterpillar (about one inch long, with two stripes the length of its body) which were represented as having destroyed twenty-five acres of meadow in the town of Saratoga Springs, were sent by Mr. F. D. Curtis, of Charlton, to the Department of Agriculture at Washington, for name. Answer was given, that "although badly shriveled and almost unrecognizable, they seem without doubt to be the genuine army-worm" (*Bulletin* No. 2 — *Division of Entomology — U. S. Dept. of Agriculture*, 1883, p. 28).

As injuries from this insect have been recorded in but few portions of the State of New York, it is of interest to note in connection with the above statement that Saratoga county is among the few places where it is believed to have previously occurred. Dr. Fitch, in mentioning its appearance, as the *black worm*, in Worcester, Mass., in May of 1817, adds, quoting from the *Albany Argus:*

This black worm is also destroying the vegetation in the northern towns of Rensselaer and eastern section of Saratoga. Many meadows and pastures have been rendered by their depredations as barren as a heath (6th–9th *Reports Ins. N. Y.*, 1865, p. 116).

The only other New York localities of its occurrence given by Dr. Fitch in his excellent account of this insect, *loc. cit.*, pp. 113–126, are the following:

Here in our own State, the worm has appeared in the vicinity of Buffalo, and at several other points toward the western and southern line of

the State; and also in numerous places on Long Island. The State Agricultural Society has received * * * specimens of the worms from the town of Dix, near the head of Seneca Lake, where they were discovered August 12th, and of cornstalks and grass as ate by them (*ibid.*, p. 117).

Anisopteryx vernata (*Peck*).

Messrs. L. & A. B. Rathbone, extensive fruit-growers, at Oakland, Genesee Co., N. Y., write as follows:

"From 1873 to 1878, the canker-worms made sad havoc in our large apple orchard of a thousand trees. After spending several hundreds of dollars in trying to destroy them, we sprayed them with London purple, and have never had to do it since."

The above appears to have been a local attack of the insect, and its arrest by the means described shows how easily it may be accomplished and its further spread prevented. While yet extremely local within our State and not of frequent occurrence, it is of the utmost importance to fruit-growers that it be not permitted to increase and extend until it shall become established in our elms, as in New England, where, from the size of the trees, it will be almost beyond control.

The Carpet-fly.

From Mr. C. A. Richardson, of Canandaigua, N. Y., were received under date of Jan. 5, 1883, specimens of "a very destructive moth found in large numbers under a carpet." They were the vacated cases of *Tinea pellionella* Linn. — the only case-bearing Tineid feeding on woolen fabrics that occurs in the United States. In the same box were contained several long, slender, white, worm-like forms, which were in all probability the larvæ of the carpet-fly, *Scenopinus fenestralis* (Linn.), subsequently re-described as *Scenopinus pallipes* by Say. Under the latter name it has been described and figured in the *Guide to the Study of Insects*, 1869, p. 401, f. 322, in both the larva and the imago stages. Dr. Packard gives the following account of it:

The larva is found under carpets, and is remarkable for the double segmented appearance of all the abdominal segments, except the last one, so that the body, exclusive of the head, seems as if twenty-jointed instead of having but twelve joints. The head is conical, one-third longer than broad, and of a reddish-brown color, while the body is white. It is 0.65 of an inch in length. The larva is also said to live in rotten wood, and is too scarce to be destructive to carpets. The fly is black with a metallic hue and with pale feet.

Mr. Richardson, in his communication, suggests that the larva may perhaps feed upon the larvæ and the pupæ of the carpet moth, with

which he found it associated. The doubt that exists in regard to its food, shows the desirability of further study of the insect.

Its identity with the European species has been shown by Dr. Loew, in Silliman's Journal, N. S., vol. 37, p. 318. Mr. Glover, in his MS. Notes on the Diptera, presents figures of it, and remarks that the fly is "very common in windows in the spring."

The structural characters of this insect have made it impossible to give it proper classification. From the peculiarities that it shows it has been taken by Dr. Loew as the type of a separate family, viz., *Scenopinidæ*. Of this family, its affinities are at present undetermined, but it is thought that it may be related to *Bombylidæ* (*Diptera of North America*, Pt. I, 1862, p. 28). Four United States species only have been included in the *Scenopinidæ* by Baron Osten Sacken, examples of which are contained in the Museum of Comparative Zoölogy, at Cambridge, Mass. (*Catalogue of Diptera of North America*, 1878, p. 97).

The Emasculating Bot-fly.

A larva taken from the scrotum of a striped squirrel, *Tamias striatus*, and agreeing in all particulars to the description given by Dr. Fitch of *Cuterebra emasculator*, in his Third Report (page 162 of Reports iii–v), was brought to me on the 13th of September, 1858, at Schoharie, N. Y. A second one had been left in the squirrel, an end of which could be seen, it was stated, through a small opening in the scrotum, made undoubtedly for the purpose of respiration.

The example brought me was placed upon some ground mixed with sand to give it less compactness, and although seemingly quite weak from having been kept for two days wrapped in paper, it buried itself out of sight in the course of two hours.

Two days later the squirrel was found where it had been left, with the grub within it and alive, lying opposite to the place from which the other had been taken, and with the tip of its body showing through the opening. Upon enlarging the opening with the point of a knife and pressing slightly, the larva slowly emerged. It was of a smaller size than the first, being but about three-fourths of an inch in length. The testicle in which it was located, had been entirely consumed. It was given some loose ground in which it buried, but reappeared upon the surface two or three times before its final burial.

Both of the above were probably immature when obtained, for neither of them developed the imago.

An alcoholic specimen of the larva, also taken from the scrotum of a striped squirrel, is in the New York State collection. It measures 0.75 inch long by 0.36 inch broad, and shows distinctly the peculiar granulated surface, the rounded ten segments, and circular mouth-parts.

For an interesting account of this insect — one of our twenty-three known species of *Œstridæ*, see the report of Dr. Fitch above cited, pages 160–167. An account of the occurrence of the larvæ (three individuals) of an allied species, *Cuterebra buccata* (Fabr.), within the body of a striped squirrel, in the region of the kidneys, is given in the *American Entomologist*, i, 1869, p. 116–17, by Mr. S. S. Rathvon. The opinion is expressed by the editors that the larvæ may have emasculated the squirrel before their transferral to another portion of the body for food.

Beet-leaf Mining Anthomyiidæ.

W. S. Miller, M. D., of South Britain, Conn., writes under date of June 9, 1884, that he is informed by an observing farmer that his beet-leaves had been infested by these larvæ for the last six or eight years [noticed first in New York in 1881], and that they had prevailed to an extent to cause the gardener much trouble. They were just commencing for the present year. A similar larva had been found by Dr. Mille in the leaves of the spinach.

Attagenus megatoma (*Fabr.*).

Examples of this beetle, one of the destructive family of *Dermestidæ*, have frequently been sent to me, as having been captured under and about carpets, with request for information of its character and habits.

Appearance. — It is an inconspicuous, small, black, shining beetle, about one-eighth of an inch long, twice as long as broad, quite regularly oval in outline, its small head bent downward and but partially seen from above. Its antennæ terminate in a large ovate club. The short legs and the body beneath are brown.

The larva, etc. — Although the beetle is a destructive household pest, yet it is without a common name. It has but lately come into notice, and its habits are not fully known. Associated as it is, in our houses, with the carpet-beetle, *Anthrenus scrophulariæ* (Fabr.), there is good reason to believe that the two are co-workers in mischief. Its larva is long and slender in comparison with that of the carpet-beetle, being about three-tenths of an inch in length. It is clothed with short brown hairs somewhat appressed to the surface, and terminates in a long pencil of hairs. This brief description is from memory as no example of it is at hand at the present writing.

Eats carpets. — The larva has been taken by me from beneath carpets and fed in confinement upon pieces of carpet, until it had completed its moltings and transformations and appeared as the perfect beetle. The insect appears to be on the increase, for not only have numerous examples occurred in my own residence during the month of

June, but it is being frequently sent to me by correspondents from widely-separated localities.

The beetle a pollen feeder. — Like the carpet-beetle, the perfect insects find at least a portion of their food in the pollen of flowers, as I have captured them in large numbers in Washington park, Albany, on the flowers of species of *Spiræa*, associated with the *Anthrenus*. The beetle, after it has done all the harm that it can in providing for a continuation of the injuries of its larvæ, by depositing its eggs upon our carpets or other woolens, then displays a desire to gratify its harmless appetite upon pollen. Seeking to leave our rooms in search of food, it flies to the windows, and if these be closed, numbers of them may be taken from the lower portions of the window casings and of the window sashes. During the month of June, frequent examinations of the borders of the carpets along the sides of the rooms in which they are known to occur should be made for these little beetles, which, when found, may, with much satisfaction, be crushed by the finger nail. Those found upon the windows should also be killed, as they may possibly not have made deposit of their entire quota of eggs.

Infests hair-cloth furniture. — From examples of the beetle which have been brought to me by a lady in Albany, and from the statement made of the conditions under which they were found, it is quite probable that it breeds to quite an extent in hair-cloth furniture, as chairs, sofas, etc. One of its congenors, *Attagenus pellio* (Linn.), which received its specific name from its fondness for dried skins, and which occurs in the United States and over most of the civilized world, displays quite a varied taste for food, for it is stated of it that it also eats cotton and linen fabrics, and is sometimes quite injurious to carpets. A writer says of it: "I have known it to select a particular stripe, especially one of red flannel in the domestic fabric known as rag carpets, and follow it out into the middle of the room, gnawing it off at intervals."

Possibly eats cotton and linen fabrics. — The carpet-beetle, *A. scrophulariæ*, has been charged with injuring lace curtains trailing upon the carpets, but from all that we know of its habits, we are unwilling to accept such statements unless they shall be verified; we believe that it only feeds upon woolen material. It is not at all improbable that we have the author of these reported injuries to cotton and linens in the *Attagenus megatoma*. If this suspicion is hereafter confirmed, and its range of food found to embrace hair, furs, cotton, linen and wool, then it is unquestionably a pest more to be dreaded in our homes than the rapacious and destructive carpet-beetle.

Remedies. — Benzine or kerosene oil will kill the eggs, larva and pupa

of this insect whenever they are brought in contact with them. It should, therefore, be freely used in their haunts underneath base-boards and the floor-joinings adjacent.

Preventives. — A material which promises to be a preventive of a repetition of the attack, if the insects be once destroyed, is the common roofing-paper prepared with gas-tar. It should be cut in strips of from eighteen inches to two feet in width, and placed underneath the border of the carpet. The odor that would penetrate heavy carpets should not be very disagreeable, and it certainly may be endured if it shall give us immunity from two or more serious carpet pests. Even thick paper or newspapers spread underneath carpets give a certain degree of protection, and none should be laid without such precaution.

Macrodactylus subspinosus (*Fabr.*).

A correspondent, Mrs. Lucy G. Chrisman, writing from Warren Farm, Chrisman, Rockingham Co., Va., gives as the result of her observations upon this insect, the well-known rose-beetle, that its depredations in that region are limited to localities having a sandy soil. Where clay occurs, the insect is not to be found. Should this statement, which, from its detail and accompanying facts, is an interesting one, be confirmed by observations throughout other sections where it abounds, it will prove to be an important portion of its life-history. It would enable us by devoting our clay soils, so far as it may be practicable, to the culture of the crops that are known to be the favorite food of this pest, to do much toward a mitigation of its ravages. The following is the statement:

Our county is a mixed sandy soil on the rivers, creeks and all the little streams, with clay land in many places between. Nowhere on the clay lands are the rose-bugs ever seen. I have a friend whose land lies on both sides of Cook's creek, and his sons' houses are quite near each other, but upon different sides of the stream; the one never sees a rose-bug; the other is eaten up with them. A mile distant is the town of Bridgewater, on a piece of North river bottom-land. In 1882, I was there in the rose-bug season, and the creatures filled the air so as to make riding exceedingly disagreeable — at times looking almost like a brown cloud — extending down to the water's edge, yet just across the river not one was to be seen. We seemed to have left them at the bridge in crossing.

A comparative exemption of a clayey district from the presence of this insect might naturally be expected from the difficulty that the female beetle would encounter in digging into the tough soil for the deposit of its eggs. But that this explanation does not meet the conditions as above given by our correspondent, appears from the statement

that she gives, that "the beetles came to us from toward the mountains in swarms, and yet on one side of a little narrow creek there are none, while on the other [sandy] side, they are abundant; and the same in many places where no creek intervenes between the sand and the clay." Their apparent dislike to clay land was so noticeable, that Mrs. Chrisman had thought of having some clay distributed over her rose-beds to see if it would not act as a repellant.

Increase of the Bean-weevil.

Mr. Joseph Barker, of Marathon, Cortland county, N. Y., states that the bean-weevil, *Bruchus obsoletus* Say, is becoming quite troublesome in his vicinity. It infests field-beans (the small yellow bean), and it is thought that persons have been sickened by eating of the beans. Three miles from Marathon, at Killoway Station on the Syracuse and Binghamton Railroad, entire fields of beans are reported as having been destroyed by the insect.

This insect was first noticed about twenty-five years ago in the New England States. It has since been of common occurrence in the State of New York, has frequently shown itself in Pennsylvania, and occasionally in localities in the Western States as far west as in Missouri.

Although it is now known in various parts of the United States, it is as yet confined to certain localities. Every effort should therefore be made to prevent its general distribution. As some of the beetles do not emerge from the beans until spring, they are liable to be planted with the seed-beans, and the evil may thereby be continued and increased. If the beans intended for seed be tightly tied up in stout paper bags and be kept until the second year, there will then be no living beetles within them, and they will be equally valuable for seed. If, however, they have been badly perforated they should not be used for planting, as many of them would not germinate.

Oviposition of Monohammus confusor (*Kirby*).

Dr. Packard has remarked of this beetle — the long-horned pine borer, that "it appears early in June and is to be found through the summer until early in September; and at any time in July and August, as well as the first week in September, it lays its eggs."

It was my fortune a number of years ago (in 1857) to have an excellent opportunity of observing the oviposition of this beetle. My record made at the time, differs in some particulars from that given by Dr. Packard — perhaps owing to the different conditions under which oviposition was made:

September 9th. Numbers of *Monohammus titillator* [*M. confusor*], were seen upon the trunks of a few pine trees [probably not exceeding ten inches in diameter] that had lately been felled upon the border of the pine grove at the cemetery [at Schoharie, N. Y.]. It was apparently, just their season for mating, for as many as ten or fifteen pairs could be counted upon a single trunk, at a time. Rarely would a single female be found unattended, and the few such that were noticed, remained so but for a short time. If during the coupling of a pair, a male chanced to discover them, a combat immediately ensued between the two males which would be fiercely contested and usually end in the interlocked combatants falling together to the ground. Upon separating and the victor returning for his prize, he might have again to contest possession with another rival. Some of the females, while still held by the male, were engaged in gnawing holes in the bark into which to place their eggs. The beetle reversing her position, and thrusting the tip of her abdomen into the excavation, deposited her egg between the bark and the wood,* as shown by examples in my collection. The egg is white, cylindrical, with rounded ends, of a length three times its breadth, and is invariably placed longitudinally with the tree.†

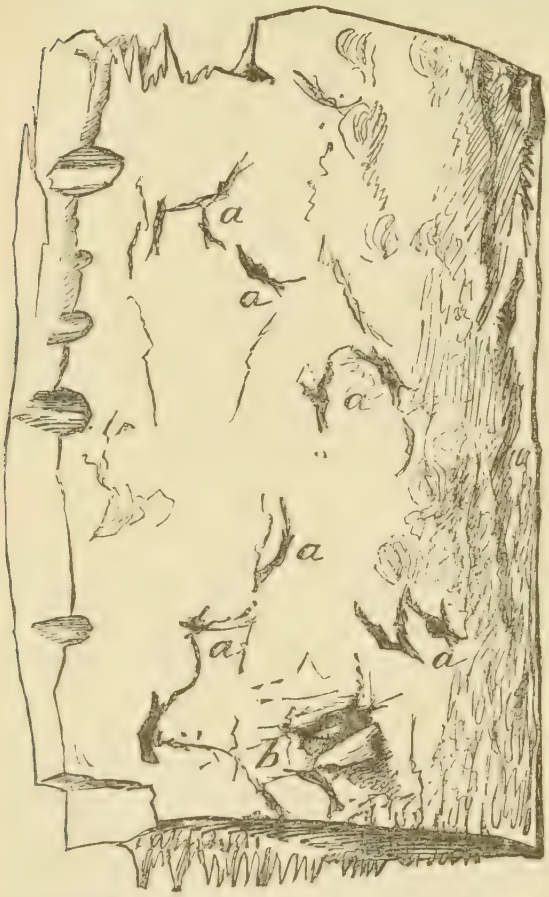


FIG. 2.—*a a, a a*. Cuttings made in a fir tree by MONOHAMMUS CONFUSOR for oviposition: *b*, one laid open to show the egg and its position — natural size.

* Upon raising pieces of the bark into which I had seen the eggs placed, the eggs usually came away with them, lying exposed, with a large section (nearly one-half) of their longitudinal diameter showing above the (under) surface. The eggs that Dr. Packard saw the beetle deposit in the fir were inserted *within the bark*, and the larvæ hatching from them, a week after oviposition "had begun to descend slightly *into* the bark" (*Ann. Rept. Dept. of Agriculture* for 1884, p. 381).

† In the accompanying figure by Dr. Packard, the cuttings for the eggs are represented as made indifferently either perpendicularly, obliquely or horizontally. In this instance they were made in a living and standing fir tree; in my observations, in felled pine trees.

An egg having been placed in position, the pair, if not meanwhile disturbed, would again unite *in copula*, after which another cavity would be made and another egg deposited, as before. Query: are repeated coitions necessary to the fertilization of the eggs, and do they require to be separately fertilized?

Another note made by me July 23, 1868, records the same beetle in abundance at Schoharie, N. Y.; on the branches of some young pines — the sexes in coitu.

Otiorhynchus ligneus infesting a Dwelling-house.

This curculionid beetle was received from Dr. C. M. Coe, of Lycoming, Oswego county, N. Y., in June, 1884, for identification, with the statement that upon opening his house in the month of May, after it had been unoccupied for four years, it was found to be overrun with this insect.

Upon communicating to Dr. Coe the name of the beetle, and expressing my inability to account for its infesting his house in such numbers as stated, since nearly all of its allied species are vegetable feeders, and asking for additional information of its occurrence, he kindly sent me the following items:

The beetles were first noticed upon opening the house in the month of April, when they were found in large numbers in every part of the house, both dead and living. The living ones continued to abound without apparent diminution in number until about the first of June, since which time they have been steadily disappearing. No measures were taken for destroying them beyond a daily sweeping of the rooms and burning such as were collected. At first, as many as two quarts, it was thought, could be gathered at a sweeping. At the date of the letter written (July 10th) not one was seen where previously a hundred had been observed. Nothing had been left in the house at the time of its closing, upon which, so far as known, the beetles could have bred or fed, if attracted thither from out of doors.

As the larvæ of these species of *Otiorhynchus* so far as known live upon plants, and for the most part upon their roots, we have no explanation to offer for the remarkable abundance of this species in the instance above mentioned. *Otiorhynchus sulcatus* (Fabr.), a species introduced from Europe, has long been known to be injurious to many of the garden products in both its larval and perfect stages. As a larva, it is often quite destructive, in Europe, to the leaves of strawberries, but has not yet been known to attack them in the United States. Mr. S. Henshaw reports this species as injurious to bulbs and house-plants. In Europe it injures leaves and roots of grapevines (*Ent. Month. Mag.*, xii, 83).

Following the reception of the *O. lignicus* from Dr. Coe, Prof. Cook of Lansing, Mich., informed me that the same species, long known as a common insect, had just been discovered as injurious to the strawberry.

O. picipes has of late years been quite destructive to raspberries, in Europe, destroying in one instance, two acres of the plants, in Cornwall. The weevil strips the leaves from the plants, destroys the tender shoots, and eats the bark from the canes (*Amer. Entomol.*, iii, 1880, p. 127). Dr. Packard has recorded (erroneously?) its occurrence in Massachusetts.

For attack of *O. sulcatus* and *O. picipes* upon the raspberry and Primula see Miss Ormerod's Report for 1879, pp. 6, 7; Report of 1880, p. 4, on vines.

O. tenebricosus, of Europe, feeds on the buds, young shoots, bark and leaves of the Apricot, Nectarine, Peach, and Plum. In the larval state it injures the roots of raspberries, gooseberries, strawberries and garden vegetables (*Miss Ormerod's Manual*, p. 306).

Sphenophorus sculptilis *Uhler.*

In the notice of this insect in the *First Ann. Report N. Y. State Entomol.*, 1882, pp. 253–263, it is stated (p. 257) that it seems not to have been observed in the State of New York between the years 1861 and 1867. The following item, from the *Rural American* of July 15, 1866, appears in the *Practical Entomologist*, for November, 1866 (vol. ii, p. 20), from a correspondent in Hannibal, N. Y.:

Mr. Miner: — Knowing that you are interested in any thing connected with agricultural pursuits, I take the liberty of sending, for your inspection, a few specimens of small beetles, taken out of three hills of corn. They burrow down in the hill, and attach themselves (head downward) to the young corn, about two inches below the surface of the ground, and insert their proboscis into the corn plant, and suck the juice until the blade turns blue and dies. I find from one to five of them in each hill. One of my neighbors has lost eight acres of corn (old sheep pasture) by them. If you can suggest any thing to stop their ravages, you will confer a favor on several subscribers to the *Rural American.*

The insects were not identified, the editor merely remarking that the "small beetles sent to us are an insect with which we are not acquainted." Mr. Walsh in copying the article, regrets that the correspondent gave no other characteristic of the beetle except that it was "small," and that the editor had not referred to him or some other entomologist for its name. It is very probable, from the habits given and the locality that the beetle was *Sphenophorus sculptilis*, which the following year was described as *Sphenophorus zeæ*, by Mr. Walsh, from examples received from Onondaga county. Hannibal is in Oswego county, which borders Onondaga county on the north.

In treating of the larval life of this insect in the Report above cited, I wrote as follows:

I can see no reason for supposing that the larva of this species should so far depart from what is known of the habits of the family, as to feed upon decaying wood. Westwood says of the *Curculionidæ*, "these insects are entirely herbivorous, some feeding upon leaves, others upon seeds, and some upon the stems of vegetables." Riley asserts (*Third Missouri Report*, p. 10), of the members of the same family, "with the exception of an European species (*Anthribus varius*) whose larvæ were found by Ratzeburg to destroy bark-lice, they are all vegetarians, the larvæ inhabiting either the roots, stems, leaves or fruits of plants, and the beetles feeding on the same."

Referring to the above paragraph, Mr. Warren Knaus, of Salina, Kansas, has sent me the following communication:

"I see that you do not indorse the idea that any of the curculio larvæ are lignivorous. I have never observed the habits of *Sphenophorus sculptilis*, having only taken two or three specimens in this county, but for the past three seasons I have taken *Wollastonia quercicola* (Boheman) from decaying cottonwood [*Populus monilifera*] logs and stumps, and have never taken them in any other locality. I have observed logs perforated in every direction, and have found small white larvæ at work in these logs, and from the same logs have taken the above-named perfect beetle. I also find the beetle in the larval burrows, but have not observed their habits sufficiently to determine definitely whether these larvæ are those of *W. quercicola*. I trust, however, that next season I may be able to test the truth or falsity of my present belief founded on observations, that the larvæ of this genus are lignivorous."

Destruction of Spruces and Firs by Bark-borers.

Extensive destruction of the spruces (*Abies nigra* and *A. alba*) and firs (*Abies balsamea*) through the ravages of bark-boring beetles has for several years past been observed in Northern New York and New England.

The attention of Prof. C. H. Peck, N. Y. State Botanist, had been called, in 1873, to the fact that in some parts of the Great Northern Wilderness of New York the spruce trees were rapidly dying, to the great pecuniary loss of the lumbermen and land-owners. In some tracts of considerable extent, nearly all the spruces were reported as having been killed, giving to the forest a prevailing brown hue as if a fire had run through them. None of these affected districts, however, came under the observation of the State Botanist at that time (27th *Ann. Rept. on the N. Y. State Museum of Natural History*, 1875, p. 75).

The following year, Prof. Peck reports, that the dying of the spruces was not of recent origin, but that it had been known in Lewis county from ten to fifteen years previous, and in Rensselaer county, the same destruction had been observed as early as the year 1845.

A locality near Lake Pleasant, Hamilton county, where the spruces were rapidly dying, was visited by him. As the result of a careful investigation made it was found that their death was owing to the countless winding galleries made by one of the bark-mining beetles, *Hylurgus* [*Dendroctonus*] *rufipennis* Kirby, between the bark and the wood. A part of each was eaten by the insect, consisting of the newly-formed and forming layers of wood and bark the most vital parts of the tree. Its operations were therefore equivalent to a girdling of the tree. In one instance, another of the bark-borers, of a much smaller size, *Apate* [*Polygraphus*] *rufipennis* Kirby, was found associated with *H. rufipennis*, in its destructive operations.

The report embraces an interesting discussion of the above attack, in its character, localities of its occurrence, frequency with which the larger trees show the attack, its cessation in some localities without apparent cause, remedies for it, etc., for which the 28th *Rept. of the N. Y. State Museum of Natural History*, 1879, pp. 32–38 may be consulted.

In the 30th *Report of the St. Museum of Natural History*, 1878, pp. 23–25, Professor Peck has given additional observations on the spruce attack by *Hylurgus rufipennis* and presented details of the operations of the beetle in the construction of its burrows.

In his following Report, Prof. Peck describes an attack upon the balsam fir, *Abies balsamea*, by another bark-boring beetle, observed by him at Summit, Schoharie county, N. Y., through which a number of trees had been killed and others were dying. The burrows were carried underneath the bark in a horizontal direction, so that three or four occurring at about the same height in the trunk would completely girdle the tree and destroy its life. The beetle proved to be a *Tomicus* of probably an undescribed species (31st *Rept. of the N. Y. State Museum of Natural History*, 1879, pp 22, 23).

The following determination, contained in a letter received by me from Dr. LeConte, in December of 1877, is believed to refer to the above insect: "*Tomicus*, related somewhat to the European species, *suturalis*, *curvidens* and *laricis* — perhaps imported." Dr. LeConte desired additional specimens "of the male with the hairy head" to be sent to him, which probably for some reason, was not done.

Dr. A. S. Packard, in his *Insects Injurious to Forest and Shade Trees*, 1881, pp. 219–227, has written of the destruction of spruces and firs in Northern New England in 1878–1881, and states, as the result of his observations and of reports made to him, that the destruction of the spruces was chiefly owing to three species of the cylindrical bark-boring *Scolytidæ*, viz., *Pityophthorus puberulus*, *Xyloterus bivittatus*, and *Xyleborus cælatus*. These, aided by *Monohammus confusor*, were also found to have caused the death of large and healthy firs, a foot in diameter.

In the *Report of the Commissioner of Agriculture* for the year 1884, Dr. Packard has presented a "Second Report on the Causes of the Destruction of the Evergreen and other Forest-trees in Northern New England and New York." In the Adirondacks of New York, he had found many dead spruces and firs with their "bark filled with species of *Dendroctonus* and *Tomicus*, or allied genera. Living spruces with the leaves fresh and green, contained in their bark, in June, the larva and the beetle of *Hylurgops*, running their burrows so as to girdle the trees. In Northern Maine the destruction of the spruces was still continuing, but was apparently abating.

Remedies. — As remedies for the ravages of these bark-borers, Professor Packard has proposed: Stripping the dried bark from infested trees and burning it. Cutting down dead trees and disposing of them for fuel. Stumps remaining from trees recently cut, should be barked, and the bark burned.

In the Harz forests in Germany, where one of these bark-borers, *Bostrichus typographus*, has occasioned such enormous losses, causing in the years 1780–1790, the death of two million of trees, other methods for arresting its continued attack have lately been resorted to, under the direction of the Forestry Commission. They are thus stated:

Experienced men are told off, to go through the forest and search for the trees attacked by the beetle, and fell and bark them to prevent the spreading of the insects. In most cases they are quite able to hold the insects in check. These generally attack trees loosened in the roots by wind, known after the beetle gets in by their foliage turning yellow. In spring, when they are worst, *healthy living trees are felled at the southern margin of the forest in many spots, for the purpose of attracting the beetle.* Such trees are often full of them three or four days after being felled. The trees attacked are barked, which destroys the larvæ if not too far advanced; if so, the bark is burned. To prevent any escaping while barking, a cloth is spread under the stem.

The above method, it is believed, could be employed with great benefit for the prevention of our spruces and firs in infested districts. The attraction that newly-felled trees have for many of the bark and timber-boring beetles at the season of their oviposition has often been recorded in our entomological literature. Note has been made in a preceding page of the numbers of *Monohammus confusor* that were drwan to some pine-trees for oviposition.

Distribution of the Harlequin Cabbage-Bug.

In the 1st Annual Report of the State Entomologist some speculations upon the probable future extension of the range of *Murgantia histrionica* into New York, the Eastern States and the Dominion of

Canada, were indulged in, based upon its observation in Denver, north of the isothermal line of 40° Fahr.

The following observations of it, by Mr. A. S. Fuller, of Ridgewood, N. J., kindly communicated to me, would indicate a power of endurance of cold possessed by it, to a far greater degree than hitherto supposed:

"I have seen it by the millions feeding on sunflowers in New Mexico, at an elevation of 9,000 feet, where a temperature of 30° below zero in winter is not at all unusual."

Dactylopius longifilis *Comstock.*

This Coccid was received July 8, 1882, from Mr. George B. Simpson. It occurred in Waterbury, Conn., on the prickly-pear cactus, where it was first observed the previous winter. Mr. S. states that the eggs seem to be placed, in preference, on the strips of cloth with which the plants are tied to the stakes.

For the description and illustrative figures of this species, see Prof. Comstock's Report in the *Report of the Commissioner of Agriculture* for the year 1880, p. 344, pl. 11, f. 2, and pl. 22, f. 1.

Heliothrips hæmorrhoidalis *Bouché.*

In my First Annual Report on the Insects of New York, in the list of Insect Depredators upon the Apple-tree, the above species was included upon the statement of its observation by Mr. Theodore Pergande, of the Entomological Division of the Department of Agriculture, as follows:

"This year [1882], as late as November 14, after several quite cold days, I found for the first time *Heliothrips hæmorrhoidalis* Bouché, on apple leaves in the orchard of the U. S. Department of Agriculture, as lively and active as in hot-houses, where this species was only observed previously."

The special study which Mr. Pergande is giving to the *Thripidæ*, an interesting and but little known family of the Homoptera, renders valuable the following note from him in relation to the above insect:

"I wish to call your attention to the fact that *Heliothrips hæmorrhoidalis* is not strictly an insect which depredates on the apple, but which was only accidentally on the trees, having evidently wandered from the hot-house plants near by to the apple, and was not again seen on the trees the last year. If the climate would be constantly warm, I have no doubt but that it would live and multiply on the apple as well as it does on a great variety of plants which are kept in hot-houses. I simply mentioned it to show how readily foreign species of insects may be introduced, if they find the climate and other conditions congenial to their propagation."

INJURIOUS LEPIDOPTEROUS INSECTS.

Melittia cucurbitæ Harris.

The Squash-vine Borer.

(Ord. Lepidoptera: Fam. Ægeriadæ.)

Ægeria cucurbitæ Harris: in New England Farmer for Aug. 22, 1828, vii, No. 5, p. 33; Amer. Journ. Sci.-Arts., xxxvi, 1834, p. 310–11; Treat. Ins. N. Eng., 1852, p. 252–3; Ins. Inj. Veg., 1862, p. 331, figs. 159, 160, pl. 5, f. 8; Entomolog. Corr., 1869, p. 284–5.

Ægeria cucurbitæ. Riley: 2d Rept. Ins. Mo., 1870, p. 64.— Reed: in Rept. Ent. Soc. Ont. for 1871, p, 89–90, figs. 96–98.— Thomas: 6th Rept. Ins. Ill. [1877], p. 41.— French: in 7th Rept. Ins. Ill., 1878, p. 173.— Marten: in 10th Rept. Ins. Ill., 1881, p. 107 (larva).— Saunders: Ins. Inj. Fruits, 1883, p. 361–2, figs. 370–372.

Melittia cucurbitæ Packard: Guide Stud. Ins., 1862, p. 279, f. 210; in Hayden's 9th Rept. U. S. Geolog.-Geograph. Surv. Terr., 1877, p. 769, f. 36.— Cook: in 13th Rept. St. Bd. Agricul. Mich., 1875, p. 116 (in Mich.).— Coleman: in Papilio, ii, 1882, p. 50 (larval hibernation).— Hulst: in Bull. Brookl. Ent. Soc., vi, 1883, p. 10 (habits, etc.).—Lintner: in Count. Gent., xlix 1884, pp. 477, 487, 517.

Melittia Ceto Grote: New Check-List N. A. Moths, 1882, p. 10.

A correspondent of the *Country Gentleman* has sent to that journal the following communication, telling of the ineffectual efforts made by him and his neighbors in dealing with the squash-vine borer, and asking for information of the insect, and approved means of checking its destructive attacks. Similar appeals and inquiries from several other localities have shown an urgent need of the information asked for, in view of a widespread extension of its injuries, while at the same time assuming a more serious character than in the earlier years of our acquaintance with the insect:

Eds. Country Gentleman — I have read in various numbers of your paper statements of crops of Hubbard squashes and prices obtained for them. In behalf of a large number of your subscribers in the valley

of the Hudson, I ask the State Entomologist to give us the full history of an insect that stings the squash vines after they have commenced to run, and lays an egg in the puncture, which shortly develops into a maggot or grub, 1 1-4 to 1 1-2 inches long, that soon, if left alone, eats and bores the vine so as to destroy all its substance, and of course kills it. We would like its full history; its scientific name; how and when it breeds; what changes it undergoes after the boring stage, in which they make such havoc in squash vines; what the perfect insect looks like, and above all, how we are to best meet it. Every one here has given up raising the Hubbard squash, and the insect has gone to laying its eggs in the pumpkin vines for want of something better. Every remedy tried has failed — even going over each vine daily and cutting out the parts where the insect lays its eggs. For the last crop I tried to raise, I spent nearly $100 in labor, going over the vines each day and cutting out the grubs. I should not have grudged this if it had saved the crop, but it did not. I lost every vine, and did not have a single squash.

We have never tried poison, as the borer is in the very center of the vine, and I do not see how the poison can reach it. It is possible that the State Entomologist can suggest something that would put an end to the pest. To give some idea how bad it is, I would say that I have cut out one hundred and forty-two grubs from a single vine, though not at one time. I have lately thought of making a box six feet square, and covering it tightly with a mosquito netting, and using this to cover each hill. It will be costly, buf if effective I could stand it, for I do not like to have an insect get the best of me, and deprive me of so delicious a vegetable. I have seen complaints of these borers in your paper, and have seen it ascribed to a dozen different insects. Therefore we look to the State Entomologist to give us the truth. P. V. B.

Coxsackie, N. Y.

The insect of which inquiry is above made, is the one commonly known as the "squash-vine borer." It was described by Dr. Harris, from the moth, as *Ægeria cucurbitæ*. Later it has been transferred to the genus *Melittia*, and as *M. cucurbitæ* it has been frequently referred to by recent writers. In a check-list of North American moths, by A. R. Grote, published in 1882, it is regarded as identical with a species described by Westwood of England prior to Dr. Harris' description, under the name of *Ceto*, but until its identity is more clearly shown, it may better retain its well-known and appropriate name of *cucurbitæ*. Fig. 1 represents the moth (a male) one-half larger than the natural size.

Description of the Moth.

The earliest description of the species is that of Dr. Harris, in the *New England Farmer* for August 22, 1828. It is of the moth only, and is as follows:

"Body tawny, with four or five black dorsal spots; anterior wings

olivaceous brown; posterior wings, except the margin and nervures, hyaline; tibiæ and tarsi of the hind legs densely fringed with fulvous and black hairs. Length of the body half an inch. The wings expand one inch and one-quarter." Later (*Silliman's Am. Jour. Sci.-Arts*, xxxvi, 1834, pp. 310–311) Dr. Harris gives the following somewhat fuller description: "The wings opaque, lustrous olive-brown; hind wings transparent, with the margin and fringe brown: antennæ greenish black; palpi pale yellow, with a little black tuft near the top; thorax olive; abdomen deep orange, with a transverse basal black band, and a longitudinal row of five or six black spots; tibiæ and tarsi [shanks and feet] of the hind legs thickly fringed on the inside with black and on the outside with long orange-colored hairs; spurs covered with white hairs. Expands from thirteen to fifteen lines."

FIG. 3.—Moth (male) of the Squash-vine borer, MELITTIA CUCURBITÆ; enlarged one-half from the natural size.

In Dr. Harris' latest publication (Treatise on Insects Injurious to Vegetation), only the more salient features of the moth are given. It is referred to, as "conspicuous for its orange-colored body spotted with black, and its hind legs fringed with long, orange-colored and black hairs. The hind wings only are transparent, and the fore wings expand from one inch to one inch and a half." The colors as given above are subject to considerable variation. Mr. Hulst states: "The ordinary orange color is more marked in the female than in the male. One female had the body almost wholly black. In some specimens yellow takes the place of orange, and in one fresh male the abdomen was almost white, and the fringes of the legs, ordinarily orange, were very light yellow."

Description of the Larva.

In none of the editions of the Harris report is the caterpillar which develops into the moth described — a strange omission, since it is in this stage that it is met with by the squash-grower hundreds of times more frequently than is the perfect insect — the popular remedy against the insect being the cutting out of the caterpillar from the vine. In Dr. Harris' Entomological Correspondence, published in 1869 (pages 284–5), it is, however, described minutely, as follows:

"Aug. 15, 1841 — Fully grown larva. Somewhat depressed, fleshy, soft, tapering at each extremity; segments ten in number, very distinct, the incisions being deep; the eleventh or last segment minute, and hardly distinct from the tenth. Head retractile, small, brown, paler on the front, and with the usual V-like mark on it. First segment or collar, with two oblique brown marks on the top, converging behind. A dark line, occasioned by the dorsal vessel seen through the transparent skin along the top of the back, from the fourth to the tenth rings

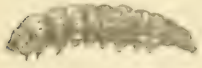


FIG. 4.—The Squash-vine borer, MELITTIA CUCURBITÆ.

inclusive. True legs six, articulated, brown ; prolegs wanting, or replaced by double rows of hooks in pairs beneath the sixth, seventh, eighth and ninth rings, and two single rows under the last rings. Spiracles brown. A few very short hairs on each ring, arising singly from little hard points or pit-like, warty substances. Length from one inch to one inch and a fourth."

This is followed with the statement that on "August 17th, one of these formed its cocoon of fragments of squash-stalks tied together with a few silken threads." It is preceded with the mention: "Found summer and winter near the roots of squash vines, and also in the roots"—probably referring to the cocoons. The larva is shown in Fig. 4, and in Fig. 5, the cocoon containing its pupa. Those who have access to the edition of Harris' "Insects Injurious to Vegetation," containing colored plates (published in 1862), may find there (pl. V. fig. 8) a figure which will enable them readily to recognize the insect when it is seen, during the month of July, flying over the plants, and alighting, from time to time, to deposit an egg. To others it may be of service to state, in addition to the above description of the moth, that the insect belongs to the family of *Ægeriadæ*, sometimes known as "clear-wings," from the wings being without scales. In this species, however, only the hind wings are transparent, the front ones being opaque, and covered with scales, as in nearly all of the *Lepidoptera*.

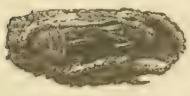


FIG. 5.—Cocoon showing the pupa of the Squash-vine borer.

The Family of Ægeriadæ.

The *Ægeriadæ* bear a marked resemblance to wasps and hornets, with their orange markings, narrow and usually transparent wings, and their flight by day. Most of them have at the end of the body a tuft or brush of stiff hairs, which they can spread out, at pleasure, like a fan. The currant-stem borer (*Ægeria tipuliformis*) illustrated in Fig. 6, and the peach-tree borer (*Æ. exitiosa*) are perhaps the best known species of the group. Within a few years past the number of species of this interesting family of internal borers in plants, shrubs and trees, has been largely augmented, through the studies of Mr. Henry Edwards, of New York. The latest check-list gives one hundred and eleven North American species, arranged in seventeen genera, while Dr. Harris' Catalogue of North American Sphinges, published in 1834, named but twelve species.

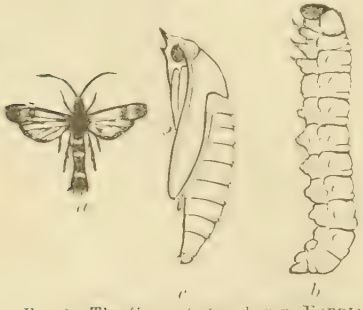


FIG. 6.—The Currant-stem borer, ÆGERIA TIPULIFORMIS; *a*, the moth, the natural size; *b*, the larva, and *c*, the pupa, both greatly enlarged.

Life-History and Habits.

Our knowledge of the several stages of the life of this pest is quite incomplete, as we find when we attempt to indicate the best methods for preventing its injuries.

In the New England States the parent moth, according to Dr. Harris, may be seen flying about the plants from the 10th of July until the middle of August, attaching its eggs to the vines close to the roots. Its habits have been carefully observed by the Rev. Mr. Hulst of Brooklyn, N. Y., to whom we are indebted for the following statement: "The moth appears on Long Island shortly after July 1st [and probably earlier.] During the summer of 1882, I captured some thirty specimens about a small bed of summer squashes in a neighbor's garden. The moths fly during the day, being the most active during the hottest sunshine, and quiet in the early morning. I have seen only two pairs mated, and this was between 2 and 3 P. M. The female lays her eggs morning and afternoon, mostly on the stalk of the plant just below the ground. She extends her abdomen into the crack of the ground about the stem of the plant, and the most of the eggs that I have seen were from one-fourth to half an inch below the surface. Often, however, they were laid a foot above the ground, and in a few instances were observed upon the petioles of the leaves."

The egg is oval and of a dull red color. The length of time required for its hatching is not known, but it is probably about a week. Upon hatching, the young larva at once burrows into the stem. It grows rapidly, and when about half-grown, its effects are visible in the wilting of the vines. Later, as the attack continues, and several larvæ unite in it, the vines die down to the root. This, in the latitude of New York, is usually in the month of August.

About the first of September some of the larvæ have attained their full growth, when they escape from the vine and construct their cocoons a little below the surface of the ground in which to undergo their subsequent changes, first to the pupa and lastly to the imago or moth. It is possible that the larva does not always enter the ground for its final transformations. Dr. Harris distinctly states that the cocoon is formed in the ground of earth cemented by a gummy matter, but Dr. Packard records of the larva that "it lives in the vine (in New England) until the last of September, or early in October, when it either deserts the vine and spins a rude earthen cocoon near the roots, or, as is often the case, remains in the hollow it has made in the stalk, and then changes to a chrysalis."

Mr. Henry Stewart, of Hackensack, N. J., who has made a study of

the insect, says that he has never found the cocoons within the vines and that they do not pupate therein.

In the Southern States the more advanced larvæ mature and form their cocoons as early as in the month of August. Of some examples received by me from Baltimore, Md., one of them spun itself up in a silken cocoon in an angle of the box in which it had been placed on the day of its reception, August 14.

Until recently it has been supposed that the larva changed to a pupa shortly after it had made its cocoon, in accordance with what has been observed in the transformations of by far the larger portion of our insects. More careful observations seem to show that the larva, usually at least, continues in its caterpiller state throughout the winter. Mr. N. Coleman, of Berlin, Conn., under date of February 24, has given the following statement:

"From numerous observations, I am assured that this insect hibernates in the caterpillar stage, and does not transform to the pupa state until the spring. The pupa cases [cocoons] are formed in the latter part of the summer, and, in every instance thus far, I have found the larvæ in the cases unchanged. The last examination was made only a day or two since."

With the emergence of the moth from its pupal case early in July, as previously stated, its appearance on the wing, the coupling of the sexes and the deposit of the eggs, its life cycle is completed.

Its Injuries.

The reports of injuries by this insect are becoming more frequent, and are assuming a more serious form than heretofore. It was formerly supposed that the earlier squashes were the more liable to be infested by it, but of late the Hubbard suffers the most severely, and to an extent that in some localities is preventive of its culture. The statement given on a preceding page by P. V. B., of Coxsackie, of the effort made to repel the attack, the expenditure involved, the cutting out of *one hundred and forty-two larvæ from a single vine*, and the entire subsequent loss of the crop, tells more fully than has been told before, the story of the harm that this pest is now inflicting, not only along the Hudson river, but in some of the Eastern States, New Jersey and elsewhere — fortunately not to as great an extent, as yet, in our Western States. The gentleman, in a subsequent communication, informs me that it has been only known in his vicinity for the last twelve or fifteen years, and during that time he has taken thousands of the borers from the vines, in sizes varying from newly-hatched to one inch and a half long.

In New Jersey the insect seems to abound, and extensive injuries are reported. A gentleman from Hackensack writes: "I have taken over a hundred of the borers from one squash vine in the past few days [in August], finding them in different parts, from the roots to the end of the vines."

Although reported occasionally as a borer in pumpkin vines, it is not known as the cause of serious harm to this plant. It also occurs in melon vines.

Remedies and Preventives.

Until the life-history of this species has been worked out with some degree of completeness — which can only follow many careful observations upon the habits and the several stages and conditions of the insect — can we be prepared to announce the best method of preventing its ravages. For the present, therefore, we must be content with giving such measures as promise material mitigation. Among those to be referred to, one or more, if carefully employed, will in all probability be found effectual in bringing the pest under control, so that entire crops of squashes will not be hereafter completely cut off; and complaints like the following (coming from Ulster county, N. Y.), need not be repeated: "I can fight off the striped bugs, but these little subterranean rascals are too much for me. I have frequently changed the location of my squash plot, and though occasionally managing to raise a small crop have oftener failed" (*Country Gentleman*, March 5, 1874, page 151).

First in order, those methods may properly be considered which may be employed at any time after the removal of a badly infested crop, with a view of preventing the recurrence of the attack the following year.

Crushing the larvæ by plowing, etc. — In the autumn, the entire field in which the borers have abounded should be plowed and harrowed two or three times. Such thorough working of the ground would crush the cocoons and their inclosed larvæ thrown up by the plow. It is believed that very few could by any possibility escape injury sufficient to prevent their final development. The depth of the plowing need not exceed the depth to which the larvæ bury themselves beneath the surface for pupation (probably not more than six inches ordinarily, but to be definitely ascertained hereafter).

Gas-lime, kerosene, etc. — A liberal distribution of fresh gas-lime, when procurable, after the removal of the crop, would kill the larvæ within the cocoons. Sprinkling the ground with kerosene oil before a heavy rain to carry it into the soil, might be as efficient as gas-lime. If mixed with soapsuds it might perhaps do quite as well. An infested crop should not be followed by another upon the same ground. A few

hills might, however, be planted to serve as a decoy to concentrate the attack — the vines with their contained larvæ to be destroyed before the time for pupation. The parent moth seldom flies to any distance for oviposition, if the larval food plant is at hand.

Protecting by netting.— Covering with netting, as a method of preventing the deposit of eggs, by stretching netting (mosquito netting) upon a large frame, of perhaps eight feet square, over the plants, as has been suggested, I regard as well worth the trial. If the frames be used upon ground where the squash has not been previously grown, and where the insect is not already in the soil, it should prove an effectual preventive, if the eggs are all deposited near the root. But if oviposition is made, as has been stated by some writers, along the entire vine to its end, then the frame could prove but partially protective. Might it not be possible, by late planting, to limit the growth to the area of the frame until the time for the deposit of eggs shall have passed?

Cutting out the larvæ.— Until recently, no other method of protection from this insect than that of cutting out had been suggested. It has been largely employed and, where the attack has not been severe, has proved effectual. A little practice renders one very expert in detecting the locality of the hidden depredator, in slitting the vine with the point of a pocket-knife and removing the larva. When, however, thousands have to be destroyed in order to insure the crop, the method is quite unsatisfactory. It certainly is not reliable under the great increase of the insect in recent years, as stimulated by the increased cultivation of the Hubbard squash.

Bisulphide of carbon in the ground.— In a paper read before the American Association for the Advancement of Science, at Boston, in 1881, Prof. A. J. Cook, of the Michigan Agricultural College, announced that he had found bisulphide of carbon to be an effective remedy against the squash-borer. The method was given as follows: "A small hole is made in the earth near the main root of the plant by the use of a walking stick or other rod, and about half a teaspoonful of the liquid poured in, when the hole is quickly filled with earth and pressed down by the foot. In every instance the insects were killed without injury to the plant." I regret to be obliged to state that the above claim has not been sustained by farther experiments. Prof. Cook, upon inquiry made by me, informs me that later trials with the material have failed to kill the borers, and he can no longer recommend its use for the purpose.

Rooting the plants at their joints. — Mr. Henry Stewart, of Bergen county, N. J., the author of many valuable notes on insect habits and depredations, has given the following as his method of dealing with the borer:

"Squashes in the East, and more particularly near the large cities where they are often largely cultivated for market, are infested with the squash-vine borer, the larva of an orange-colored moth (*Melittia cucurbitæ*), which not only deposits its eggs on the vines near the roots, as stated by Harris, but also, as I have often observed, along the vine here and there at the joints, the young larvæ entering the vine and burrowing it from end to end. This destroys the vine and, of course, the crop, unless counteracted by some method. The method of culture must be controlled by this danger; and to manure the ground broadcast, as well as in the hill, and cover every joint when the vine begins to run, with soil raised by a hoe, avoids the danger, because the vines root at every joint when thus treated, and the original root may be cut off and yet the vine flourish all the more from its several rooted joints. This cannot be well done with hill-manuring; but yet I have found a way to circumvent the borer even then. It is to procure Peruvian guano, or a special fertilizer prepared for squashes, and hill up around the joints as soon as the presence of the borer is perceived, or before that as a precaution, scattering a small quantity of the fertilizer (one ounce or so) about the newly earthed-up joint. At the same time, a dash or two of water in which London purple has been mixed may be thrown on the vine near the covered joint with a small bunch of broom corn. This will destroy many of the young larvæ as they eat their way into the vine, and the scent of the fertilizer may drive off the parent moth." (*Country Gentleman* for June 3, 1880, xlv, page 358.)

Treatment with saltpetre. — The following treatment of the vines with saltpetre has been recommended:

"Four tablespoonfuls dissolved in a pail of water, and about a quart applied to each hill where an attack was noticed and the leaves were wilting, at the time when the vines were just beginning to run nicely, effectually arrested the attack and a fine crop followed." (*Country Gentleman*, May 1, 1879, page 279.)

Use of Counterodorants.

In accordance with the views advanced by me and treated of at length in my First Annual Report on the Insects of New York, I believe that the deposit of the eggs upon the plant by the moth may be prevented by the use of strong-smelling substances, such as kerosene oil, coal-tar, tar-water, naphthaline, soluble phenyle, carbolic acid, and bisulphide of carbon. Experiments are needed to determine the relative efficiency of the above and like materials. It would, of course, be necessary that the applications should be renewed from time to time as their strength becomes impaired, so long as the moth continues abroad for laying her eggs — unfortunately a long period.

Efficacy of bisulphide of carbon. — I am quite desirous that faithful experiment be made with bisulphide of carbon, in consideration of its having proved effectual in preventing the attack of rose-bugs upon

grapevines, as narrated in the *Country Gentleman* of March 6, 1884, page 191. In that instance small vials containing a few drops each of the liquid were tied among the vines at intervals of a foot or two, the liquid being renewed every three or four days. As the result, grapes were grown upon the trellis as far as the vials were hung, while beyond, all the blossoms were eaten by the beetles. The cost of the bisulphide of carbon distributed in the twenty vials employed was less than twenty-five cents. The best method of using this material as a protection of squash vines, may safely be left to the judgment of the squash-grower.

Coal-tar, naphthaline, etc.—Coal-tar, as a preventive, might be dropped in patches upon the ground near the root and vines. Tar-water might be sprinkled over the ground. Pieces of cloth might be saturated with kerosene oil and wound upon sticks thrust in the ground, or sand moistened with it scattered upon the surface. Lumps of naphthaline would yield their strong odor for some time if lightly covered with the soil. Carbolic washes, if not too strong, could be sprinkled over the plants. Different methods of use of the above, as well as other materials, will undoubtedly come to the mind of one familiar with the cultivation of the squash.

Additional Information of the Insect Asked For.

That the remedies and preventives to be employed against this insect may be the best directed and the most effective, I would solicit the aid of all interested in the cultivation of the squash whom these lines may reach, in sending me information upon the following points. Each one should regard it as his duty to contribute, from his observations, to the extent of his ability.

Earliest date of the appearance of the moth. Latest that the moth is seen.

Is the egg ever deposited upon the root-stalk? If so, how often?

Greatest distance apart upon the vines that the egg is placed or the borer found.

Are the eggs placed on the upper or lower sides of the vines, or intermediately?

Is the borer ever found in the main stalk?

Earliest and latest notice of injury from the borer.

Earliest maturity of the borer and escape from the vine for pupation.

Are the cocoons ever found within the vines?

At what depth in the ground are the cocoons buried?

Are the cocoons ever found far from the vines?

Does the caterpillar ever change within the cocoon to the pupa during the autumn or winter? (In this stage it shows the legs, wing-covers and other organs of the future moth.)

What means have been found the most successful against the borer?

The number of points above given upon which information is desired, will serve to show that very little is known of this destructive insect and its habits, and that it is now proposed to give it the critical study that it has hitherto failed to receive.

Experiments at the State Farm.

Following the above request for additional observations and experiments upon this insect, Mr. E. S. Goff, horticulturist of the New York Agricultural Experiment Station, has very kindly communicated to me the gratifying results of his experiments upon it at the Station, both with insecticides and counterodorants, together with observations upon its habits, transformations, etc.

Under date of September 29, 1884, the following communication was received from him:

"It gives me pleasure to write to you that my experiments upon the squash-vine borer (*Melittia cucurbitæ*) offer much hope that we shall be able to battle this enemy with success. It has not been troublesome with us this season, though it has appeared in sufficient numbers to give an opportunity to show the value of my applications. I have just made a very thorough examination of the vines experimented upon, pulling up each plant and carefully looking over the stem. I found in seven hills of Hubbard squash, to which I had made no application, twenty borers (or cavities where they had been). In seven hills of the same, where I used a solution of copperas about the roots, I found eighteen borer cavities. In eight hills of the same variety I wet the stems a distance of two feet from the base of the plants with water containing Paris green at the rate of half a teaspoonful to a gallon, after every rain, from the middle of July to the first of September. In these plants I found only eight borer cavities, *all of which were farther from the base of the plants than the Paris green water was applied.* In eight hills of the same variety I placed cobs dipped in coal-tar, five in each hill; following out the suggestion that you gave me, I re-dipped the cobs from time to time during July and August. In these plants I found but three borer cavities.

"In sixteen hills of the Perfect Gem squash, where nothing was applied, I found fifteen borer cavities. In eight hills of the same, where I used the soap emulsion on the stems, in the same manner as I used the Paris green mixture in the case noted above, I found but two borer cavities.

"I think that these results give hope that we may very largely diminish, if not entirely remedy the damage wrought by this insect, by a thorough application of insecticides to the stems, or the use of counterodorants."

In the above experiments, the application of the soap emulsion seems to have given the best results, provided that the "Perfect Gem" squash is as subject to attack as the "Hubbard," as eight hills gave but two

burrows. Next to this comes the coal-tar employed as a counterodorant, showing in the same number of hills but three burrows ; and, third, the Paris green water with eight burrows.

The average protection shown in the above experiments (not including that with the copperas water) is eighty-one per cent — a highly gratifying result.

Had the applications been commenced about the first of July, instead of the middle of the month, it is probable that the results would have been still more satisfactory. The moth, in the State of New York, may commence the deposit of its eggs during the first week of July. The coal-tar would act by preventing the deposit, while the Paris green water and the soap emulsion operate by killing the young larva upon its hatching from the egg and beginning to eat into the vine.

In a subsequent communication, Mr. Goff, in reply to inquiries, contributes these items relating to the life-history of the species :

" Strange to say, I found but two live larvæ ; in almost every case they had left the vines for transformation. * * * * * * * I found no pupæ within the vines. In one or two cases the caterpillar seemed to have died ; at least, I found in the cavity a mass of white matter. * * * * * * * I noticed that the borers are often found in the stem at a greater distance from the base than I had supposed — often four and even six feet from the base. Strange to say, however, in the ' Perfect Gem ' squash I found the borer only close to the base, in no case, I believe, in a *branch,* but always in the main stems. * * * * * * * The ' Perfect Gem ' seems less liable to attack from the borer than the ' Hubbard.' I had noticed this fact in previous seasons."

Orgyia leucostigma (Sm.–Abb.).

The White-Marked Tussock Moth.

(Ord. Lepidoptera: Fam. Bombycidæ.)

Smith-Abbott: Nat. Hist. Lep. Ins. Georgia, 1797, ii, p. 157, pl. 79 (figs. larva, pupa, ♂ & ♀ ins.).

Harris: Rept. Ins. Mass., 1841, p. 262; Treat. Ins. N. Eng., 1852, pp. 282–284; Ins. Inj. Veg., 1862, pp. 366–368, pl. 7, figs. 1–5 (natural history, etc.).

Fitch: in Trans. N. Y. St. Agricul. Soc. for 1855, xv, 1856, pp. 441–450; 1st–2d Rept. Ins. N. Y., 1856, pp. 209–218 (detailed account); 3d–5th Repts., 1859, p. 20 (brief notice); 6th–9th Repts., 1865, p. 199 (increased injuries and remedies).

Riley: 1st Rept. Ins. Mo., 1869, pp. 144–147, figs 81–83.

Morris: Synop. Lep. N. A., 1862, p. 249 (descr. of larva and imago).

Packard: in Proc. Ent. Soc. Phila., 1864, iii, p. 331.

Le Baron: 1st Rept. Ins. Ill., 1871, pp. 13–17.

SAUNDERS: in Canad. Entomol., iii, 1871, p. 14, f. 10 (eggs and larva descr.); in Rept. Ent. Soc. Ont., for 1874, p. 19, figs. 14–16 (general notice); Ins. Inj. Fruits, 1883, pp. 57–60, figs. 50–53 (the several stages and remedies).
BETHUNE: in 1st Rept. Ent. Soc. Ont., 1871, pp. 82–3, figs. 23, 24 (brief notice); in 2d Rept. Id., 1872, p. 14 (abundance and injuries).
FRENCH: in Thomas' Rept. Ins. Ill. (vii), 1878, pp. 185–186, figs. 36, 37 (general notice).
FORBES: 12th Rept. Ins. Ill., 1883, pp. 100–1, fig. 20 (brief notice).
COLEMAN: in Psyche, ii, 1882, pp. 164–166 (larval colorational differences).
LINTNER: in Albany Evening Journal for June 25, 26 and 28, 1883; in 37th Rept. N. Y. St. Mus. Nat. Hist., for 1883, pp. 50–52 (larvæ girdling twigs).

In studying the history of our insect foes it not unfrequently occurs that a species which had long been known to entomologists, without having assumed such injurious habits as to give it place among our serious pests, suddenly increases to such an extent and so extends the range of its food-plants, as to become a conceded and permanent public nuisance.

Such an one is the *Orgyia leucostigma*, an insect broadly distributed over the United States, from Maine to Georgia and westward to the Rocky mountains. For many years it was known only as an occasional depredator upon apple trees and rose bushes. In the year 1828, according to Dr. Harris, the apple trees in portions of New England were infested with multitudes of the caterpillars, and subsequently, in the summers of 1848, 1849 and 1850, they extended their attack to many other trees, nearly stripping the leaves from the horse chestnuts in Boston.

It appears for a long time to have had but local distribution. Dr. Fitch, writing of it in 1856, had never known it to be sufficiently multiplied in the vicinity of his residence, Salem, Washington county, N. Y., to merit any attention on account of its depredations. He had never met with a half-dozen of the caterpillars in any one year, perhaps owing to the locality being near the northern extreme of their geographical range, until in the summer of 1855, when they were noticed as being unusually common.

As early as the year 1870 it had become abundant in Albany and firmly established. It has annually reappeared, with perhaps three or four exceptions, and made great havoc upon the foliage of both fruit and shade trees. One of these exceptional years was in 1874, when but few of the larvæ were seen, and another in 1884, when these notes are being revised for publication. In several other of our larger cities this insect also became a public pest. In Philadelphia they were very abundant in 1873, as appears in an article in the *Popular Science Monthly*, vol. iv, page 381, entitled, "The Caterpillar Nuisance in Philadelphia," in which a former pest [*Ennomos subsignaria*], one of the measuring-worms

exterminated by the English sparrow, is replaced by the *Orgyia*, which the sparrows will not attack.

As will be seen from the literature of this species as given above, it has already been treated of by most of our writers on economic entomology. It has also been noticed in many other minor publications not cited, and the figures originally given of it in its different stages often reproduced. But so serious are its injuries to fruit and shade trees and various ornamental shrubs, and so general the ignorance of the best means of relief therefrom, that the present notice of it seems desirable.

As a knowledge of the several stages of insect life and other particulars which enter into a life-history are of great importance in all efforts to control insect depredations, they will first be considered.

The Caterpillar.

While the perfect insect is unusually sombre in color and without the slightest ornamental feature, unless it be its prettily pectinated antennæ, the caterpillar, as if by way of compensation, is strikingly beautiful, not only to naturalists, but to all who will take the trouble to give it an examination. Dr. Fitch has written appreciatively of its beauty, as follows:

"The term 'caterpillar' is applied to a worm which is clothed with hairs; and we commonly associate this term with something which is ugly and repulsive in its appearance. But many caterpillars are far from meriting this prejudice, being, in reality, objects of much beauty. This is eminently the case with one which may frequently be seen in the month of July upon apple trees and also in our yards upon rose bushes. We cultivate the rose for ornament, and nature, as if to further our designs, places upon the leaves this neat, little, prim caterpillar, which is a more delicate, elegant object than the handsomest rose that ever grew. I well remember the first time I ever noticed one of these caterpillars. It was in the hay field, in my boyhood. One of the laborers, who had little taste for any of the beauties of nature — a man of that class of whom the poet sings,

> 'A primrose by the river's brim,
> A yellow primrose was to him,
> And it was nothing more' — -

in stooping for a handful of grass to wipe off his scythe, had his attention arrested by one of these caterpillars. Taking up the leaf on which it was standing, he was for several moments absorbed in contemplating its bright colors and the artistic arrangement of its elegant plumes. Then as he was laying it down, he said to himself, 'That is the prettiest thing I ever saw!' Let us not murmur if the leaves of our rose bushes are

somewhat gnawed and eroded, when they hereby produce for our admiration objects far more beautiful than we look for them to yield."

The caterpillar is a slender creature, measuring when full-grown from about three-fourths of an inch to an inch and a quarter in length. Its color is a cream yellow, with a broad velvety black stripe upon its back and a broader brown or blackish one upon each side. Nearly covering its sides are tufts of pale yellow hairs, which radiate from small yellow tubercles arranged in two rows; from the upper of these rows a few longer black hairs are given out. Upon the back, on its anterior half, are four erect, short, thick, even, brush-like tufts of hairs, white or creamy-yellow, placed on the fourth, fifth, sixth and seventh rings of the body. The contrast between the occasional bright yellow of these tufts and the white has been so marked as to give rise to the suspicion that they might indicate sex, but the careful observations of Mr. Coleman (*loc. cit.*) leave no ground for such belief. The same larva has, at different times, shown yellow tufts and white ones, changing from yellow to white and from white to yellow, independently of molting. From the sides of the front ring project forward in a broad V shape, two pencils of black, bearded hairs, tufted at the end and of unequal length, giving them a jointed appearance, the longest measuring a half-inch in length. On the penultimate ring (11th) is a similar pencil of brown and black hairs, which are only tufted at the end of the pencil. The head is coral-red, as are also two little knobs on the back within the black stripe, on the ninth and tenth rings. Fig. 7 shows the caterpillar.

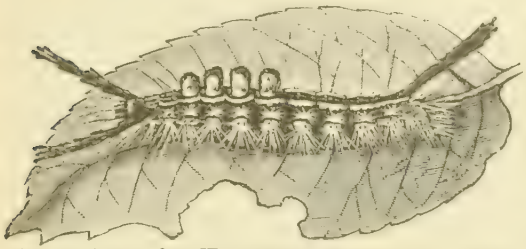


FIG. 7.—Larva of the White-Marked Tussock moth, ORGYIA LEUCOSTIGMA.

The Cocoon.

Next following the caterpillar stage, the insect is presented to us under the guise of a cocoon, attached usually to the trunk or branches of the tree upon which it had fed. Frequently, however, it wanders from its food-plant and seeks more hidden and sheltered locations, as under window-sills, beneath copings, caps of fence-posts, etc. The cocoon is about an inch in length, broadly flattened beneath, of an elongate-oval outline and of a depth barely sufficient to contain the pupa. It is very slightly woven, for, although it is double, consisting of an outer and an inner web, yet, through both, the larva, near its transformation, or the pupa, may often be seen. Woven into the outer envelope are notice-

able the long, black pencil-hairs of the caterpillar and some of the shorter yellow ones.

The Pupa.

Upon tearing open the cocoons, the pupæ found therein (the third stage in the insect's transformation) will be observed, if a number are examined, to vary greatly in size — some being less than a half-inch in length, and others exceeding seven-tenths of an inch — these last surpassing the former four or five times in bulk: the smaller ones produce male moths, and the larger, females. They are rounded in front and in their entire outline, except at the hinder end, where they terminate in a short spinous tip armed with bristly hooklets by which they fasten themselves to the threads of the cocoons. The colors are whitish and brown approaching black, particularly upon the back. On the front, back and sides are numerous short white hairs—a quite exceptional feature in the almost universal smoothness of the pupal form.

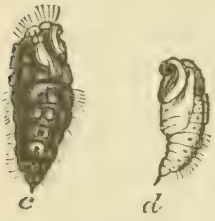


FIG. 8.—The White-marked Tussock Moth: *c*, the female pupa; *d*, the male pupa.

A prominent and characteristic garniture of the female pupa, shown at *c*, in Fig. 8, is a pale, oval or square spot composed of minute bladder-like bodies or scales on each of the principal rings (the thoracic ones) back of the head. In the male, *d*, in the figure the broad antennæ-cases, with their transverse markings denoting the pectinations of the organs, are conspicuously folded upon the breast beween the wing-cases.

The Perfect Insect.

The male moth, although far superior to the other sex in outward appearance, is not an object that would readily arrest the attention — its plain colors being in marked contrast with those worn in its caterpillar stage. Its size is rather below the average of moths and is seemingly small for the larva producing it, as it measures but little more than an inch across its expanded wings. The wings are broad and rounded in outline and of a smoky-brown color. The front pair have a gray patch on the middle of the anterior border, and are crossed by three or four blackish curved lines, of which the outermost one is quite angulated; near the outer margin is a gray band, preceded near the tip by some elongate black spots, and near the inner angle by a white spot, often comma-like in form. It is from this last that its specific name of *leucostigma* (white-mark) is derived. The hind wings are also broad, smoky-brown, without any markings, but with a darker border. Both pairs are fringed with projecting scales.

FIG. 9.—The White-marked Tussock Moth, ORGYIA LEUCOSTIGMA—position at rest; the male

The body is brown, quite slender, small in proportion to the spread of wings, and bears a small black tuft of upright hairs near its base.

The antennæ are beautiful objects — the redeeming feature of the unusual plainness. "They are about one-third of the length of the wings, gray, with a double row of dark-brown branches resembling the teeth of a comb. Each branch has a row of very fine hairs, like eye-lashes, along each side, and at its tip three bristles, one of which is much longer and directed inward toward the head" (Fitch).

When at rest, the moth has its long, hairy front legs stretched out divergingly in front of its head, with the antennæ usually extended at right angles with its body, as shown in the figure. With the recollection of this unusual attitude in connection with the features above indicated, the moth can hardly fail of being recognized during its season of prevalence — toward the last of July and early in August.

The female is of a very different appearance, being apparently wingless, having only the rudiments of wings in the form of a little pad on each side, and its ash-gray body distended with its burden of eggs when it creeps out of the cocoon, to a breadth of a quarter of an inch in a length of half an inch. Its antennæ are not branched, and it scarcely possesses any feature which would lead the ordinary observer to associate it with its mate or to regard it as a moth.

The Egg.

The eggs — the last phase as we have traced the progress, but properly, the first in the series of the four insect stages — are deposited in mass upon the surface of the cocoon, as will be hereafter described. The egg is round, with a strong, thick, cream-colored shell, and in size is about three-hundredths of an inch in diameter. It has a slight depression apically, marking the point at which the caterpillar eats an opening for its escape.

Natural History.

The life-history may next be traced in its progress through the several stages above described. The eggs are hatched at about the middle of May, varying with the season, and, perhaps, from their different exposures, for in the same locality some of the deposits have been from three to four weeks later than others in disclosing their larvæ. As has been followed by Prof. Riley, the stages of growth observed were as follows:

The first molting of the caterpillars occurred seven days after escaping from the egg. At intervals of six days each, the second and third moltings took place. Six days thereafter some of the larvæ had attained their growth, ceased feeding, and commenced to spin their cocoons.

Others, at about this time, again molted (for the fourth time), and not until after six more days did they commence inclosing themselves in cocoons. When the moths emerged, it was discovered that males were produced from the larvæ which had molted but three times, and females from the remainder.

This prolonged larval period and additional molting in the female is a very interesting scientific fact. Its occurrence in other species, as observed by me, has been noted in my first report (page 98), and it is believed that it will be hereafter discovered to be the rule in many other of the *Bombycidæ*. The bearing of this fact upon the mooted question of the comparative degree of development and rank of the sexes is worthy of consideration.

To summarize the above statement of the successive larval stages — the entire period is from twenty-five to thirty-one days — about a month. It is during this brief period that the voracious appetite, necessitated by rapid growth, causes the ravages upon our trees and shrubs of which we have so great cause to complain.

Within the shelter of the cocoon, the larval skin is cast off for the last time, and the insect, as early as the latter part of June, enters upon its pupal state. In this condition it quietly reposes for a period of from ten to fifteen days,* when the moth within the pupal shell, having by this time become fully developed in all its organs except in the extension of its wings (in the male), bursts its walls, and emerges to the light of day. The male moth — first observed by me the present season on the 9th of July— crawls to some suitable spot near to the vacated cocoon, when, within a half-hour, his contracted wings, as drawn from their pupal sheathes, attain their full expansion, and he is in readiness for flight. As soon as "evening shades prevail," he seeks his mate, and with the end of his existence attained, a few days serve to end his career.

The female moth hardly surpasses the "Bag-worm," *Thyriodopteryx ephemeræformis*, as a traveler, for while that species never emerges from her cocoon, this only works its way outward through the loosely-spun threads, and takes position upon its surface. From a power of attraction possessed by her in an eminent degree,† and shared by many of

*Cocoons spun on July 5 were found with egg-deposits upon them on July 16. Dr. Fitch records that in several instances he had known the moth to emerge thirteen days after spinning the cocoon.

†A female imago of this species had emerged August 4, within its breeding-cage, standing in a large apartment about ten feet from an open door. At dark (half-past seven o'clock), males commenced to fly into the room, and precipitate themselves against the gauze front of the cage, moving in every direction over its surface, with legs, wings and antennæ in rapid motion, in a persistent effort to force an entrance into the cage. Several

the *Bombycidæ*, it rarely, if ever, happens that she is not prepared to deposit her burden of fertilized eggs on the following day; and as if aware that her size and exposed position was an invitation to her many enemies, she enters upon the duty without delay. A connected thread of eggs is extruded from her body and attached in mass to the surface of the cocoon. As they emerge from the abdomen, they are accompanied with a viscid secretion which cements them firmly together; and when the entire number — two hundred or more — are deposited, they are thickly covered over by the same frothy substance, which soon hardening, serves as an admirable protection from unfavorable weather, from other insects, many birds and other depredators. This accomplished, the shrunken body soon drops from the cocoon to the ground, and the life-cycle of the individual is completed.

A second brood. — In the Southern States there are two annual broods of the insect, of which the moths of the first appear in May and June, and those of the second in September and October. Even so far north as Philadelphia, I have observed on the 8th of September (after a long term of unusually hot weather), an abundant second brood, at which time the mature larvæ abounded upon the tree-trunks, together with cocoons recently spun and in construction, females just emerged, and egg-deposits upon the cocoons.

In New York, a second brood occurs occasionally, at least; and perhaps annually in limited numbers, yet it is never so abundant as to be injuriously noticeable. I have seen the moth as late as October 6th.

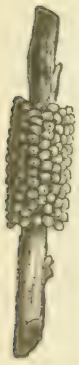


Fig. 10. — Egg-belt of Hemileuca Maia.

Hibernation. — The hibernation of this species is in the egg stage — the exception with the lepidoptera, where it is commonly in the pupal stage, often in the form of larvæ, and occasionally as perfect insects. The greatest cold of our northern winters — from 30° to 40° below zero, of Fahr. — has failed to kill them. How it is possible for them to survive such temperatures is a mystery to us. It is not from the protection afforded them by the material in which they are encased, for the eggs of another Bombycid — *Hemileuca Maia* — survive the winter equally well, although they are entirely without any covering and are exposed in belt-like manner upon the twigs of oaks,

attempted to enter through the small crevice left by the imperfectly fitting door at the rear of the cage. Three or four moths were often on the gauze at the same time, whence they could be plucked with the thumb and finger. During the hour that this exhibition continued, forty moths were taken and pinned, from at least a hundred that entered the room. *Twenty-sixth Report on the New York State Museum of Natural History*, 1874, p. 148; id., *Entomological Contributions, No. III*, p. 148.

as represented in Fig. 10.* The eggs of butterflies having still thinner shells than the above, have been exposed for hours to freezing mixtures of —22° Fahr., without injury to them. It is probable that the eggs of most of our insects are in reality not frozen under the greatest cold to which they would be subjected under natural exposures. Some eggs of *O. leucostigma* which I had taken separately from their covering and left exposed during a portion of the winter, were examined by me under a temperature of —18° Fahr., and were found to be in their natural fluid condition.

Food-Plants.

An important inquiry, whenever a noxious insect presents itself for investigation, is its range of food, to serve as a guide to the probable extent of its depredations, and the possible means of checking its spread. In the year 1861, when the citizens of Brooklyn were greatly excited over the increase of a "measuring-worm,"† which had become an unendurable nuisance from the myriads that hung suspended by their silken threads from the branches of the shade-trees of the principal streets, the following resolution was discussed by the common council:

"*Resolved*, That the owners of property having linden trees on the streets are hereby ordered to remove them within ten days after the passage of this ordinance, and failing to do so, shall be liable to a fine of five dollars for each tree left upon the streets, after that date. The street commissioner is hereby ordered to remove all trees of that species that may be left on the streets after that date."

The resolution having been referred to a committee, failed to be reported favorably and to become a law, for the reason that upon scientific examination it was found, that while the caterpillar was more abundant upon linden trees, it also occurred and fed upon the elm, weeping-willow, silver-leaved poplar, balm-of-Gilead, maple, horse-chestnut, some of the fruit-trees, shrubs and herbage.

Occasionally an insect seems to be so extremely particular in its food as to confine itself to a single species, but more commonly it is found feeding upon the several species of the same genus. Others extend their range to the several genera of the same family, while others still, known to us as polyphagous species, attack plants of very dissimilar characters, comprised under several orders. In illustration of the last, we may cite the habits of two species of well-known *Bombycidæ*, viz.: *Samia*

Twenty-third Report on the N. Y. State Cabinet of Natural History, 1872, pp. 137–141; *Entomolog. Contrib.* [*No. I*], 1872, pp. 5–9.

†The larva of the snow-white linden-moth, *Ennomos subsignaria* Hübn.

Cecropia (Linn.) and *Telea Polyphemus* (Linn.). The former is recorded as feeding upon forty-nine species of plants,* belonging to nineteen genera, and to nine natural orders — the orders being *Tiliacew*, *Aceracew*, *Rosacew*, *Saxifragacew*, *Caprifoliacew*, *Urticacew*, *Cupilifera*, *Betulacea* and *Salicacew*: the latter, *Polyphemus*, upon the same number of species, in sixteen genera, and in eight orders. (Wm. Brodie, in *Papilio*, ii, 1882, pp. 32–3, 58–60.)

The Orgyia caterpillar has not been favored with so careful a compilation of its food-plants; the following, presumably the more common ones, are recorded: Linden (*Tilia Americana*), horse-chestnut (*Æsculus hippocastanum*), locust, rose, plum, cherry, apple, pear, elm, butternut (*Juglans cinerea*), black-walnut (*Juglans nigra*), hickory (*Carya alba*), oak, spruce, fir, and larch. I noticed it last summer, in September, seriously injuring the foliage of some castor-oil plants, *Ricinus communis*.

Depredations.

On the horse-chestnut. — The horse-chestnut, which had steadily been growing in popular favor as a shade-tree, from the almost entire immunity which its foliage has enjoyed from insect attack,† has of late years been apparently chosen by the Orgyia for its favorite food-plant. It might be thought that a leafage so dense and luxuriant would afford more than the required amount of food for any number of insect depredators that could assemble upon it; but in seasons favorable to the multiplication of the insect, the largest trees in the city of Albany have shown the pitiable spectacle of a foliage entirely consumed — only the ribs of the leaves remaining. Not only were the trees left useless for shade, but their lives were endangered, for, although under favoring conditions of moisture and not excessive temperature, a second feeble leafage would sustain their existence, yet a repetition of the attack the following year could hardly fail of proving fatal. Hosts of greedy caterpillars could be seen deserting their exhausted feeding grounds and descending the trunk in search of the food still needed by them.

On the elm.— The elm is also injured to a degree not much less than the horse-chestnut. The immense size of most of the white elms (*Ulmus Americanus*) planted for shade, offers, in their long limbs and spreading branches, more abundant food, and in a measure diffuses the ravages that they sustain, yet frequently a large proportion of their

* Not such as the cocoon and larva may have been found upon, "but held to be such as a perfect female *Cecropia*, at liberty, will select as food for her young."

† Besides this species, I can recall but two other caterpillars that feed upon it, viz., *Acronycta Americana* Harris, and *Ennomos subsignaria* (Hübn.), and these, usually, to quite a limited extent.

leaves have been skeletonized, or so riddled that they wither, dry, and drop to the pavement.

On fruit-trees.— Dr. Le Baron, has recorded that "on the second day of September my attention was called to an orchard a few miles from my residence [at Geneva, Illinois], in which all the trees in one corner of the inclosure, to the number of fifteen or more, had been entirely stripped of their foliage by these caterpillars, whilst they were at the same time well loaded with fruit."

Dr. Fitch states that in 1863, in Albany, they completely stripped large plum trees of their leaves, and rose-bushes were similarly defoliated. (*6th to 9th Repts. Ins. N. York*, 1865, p. 199.)

On Cape Cod, Mass., in 1884, when the larvæ generally were less abundant than usual, they are reported by Mr. J. B. Smith as stripping the leaves everywhere. (*Canad. Entomol.*, xvi, p. 183.)

Some plum trees that were under my almost daily observation were nearly stripped of their leaves before the attack was noticed.

In Central Park, New York.— During the summer of 1883 the insect was very prevalent in many portions of the State of New York and in adjoining States. In New York city the extensive defoliation of the shade-trees in midsummer was felt as a public calamity. In Central Park the ravages were particularly noticeable. When they had reached a point that threatened the destruction of many of the infested trees, the park commissioners were compelled to take action to arrest, if possible, the attack. The collection and destruction of the eggs was ordered. The work was undertaken under the direction of Mr. E. B. Southwick, in charge of the inspection of trees and shrubs, and, as the result, as he has informed me, between the 13th of August and the 16th of October, the four men engaged in the work, armed with hooks and scrapers of various kinds, steel brushes and brooms, went over the entire park and collected *thirteen bushels of the Orgyia eggs and cocoons* and burned them.

Parasites.

Upon one occasion Dr. Le Baron found the cocoons of this species, which were very abundant upon some apple-trees, extensively infested by the pupæ of a Tachina fly, which was named and described by him as *Tachina orgyiæ* (1*st Rept. Ins. Ill.*, p. 16). Very few of the cocoons examined were free from the Tachina parasite ; two, three and sometimes four were contained in them. Of the myriads of the cocoons observed, it appeared that scarcely one out of a hundred had escaped the fatal visitation of this parasite.

From one of the caterpillars Dr. Fitch bred a number of minute para-

sites belonging to the family of *Chalcididæ*, which were described by him under the name of *Trichogramma? Orgyiæ*. Another species, resembling this so closely as to have been named by him the "brother parasite," *Trichogramma fraterna*, was found by him under conditions that led him to believe that it was also parasitic on the *Orgyia*. These species have been subsequently referred to the genus *Tetrastichus* by Mr. Howard, who is of the opinion that they will prove to be not parasites upon the *Orgyia leucostigma* larva, but upon a species of *Pteromalus* which is parasitic upon it. This *Pteromalus* has been reared by me in large numbers, but, in the uncertainty that attends the numerous described species of this extensive genus, it remains at the present undetermined.

I have also obtained from the eggs of the *Orgyia* a minute parasite, which has been generically determined by Mr. Howard as *Telenomus*.

A species of *Hemiteles* is a very common parasite upon the larva in the vicinity of Albany, and in some seasons it has proved to be the principal instrument in arresting its multiplication.

There is also in my collection a Tachinid fly obtained from an *Orgyia* in 1879, which differs from the species described by Dr. Le Baron, in that it has two large reddish spots on each side of its abdomen, and that its white tegulæ, instead of being translucent, are quite opaque. The *Tachina orgyiæ* is not at all uncommon with us.

The Great Increase in its Ravages.

That this insect has very largely increased in numbers and in destructiveness during the last twenty years is evident to all who have followed its history during that time, or to those who have but recently been drawn to notice it as a new depredator. To what cause, it may properly be asked, is this great increase owing?

An unusual abundance of a particular species of insect for a single year is a phenomenon of common occurrence, which can easily be accounted for from the operation of well-known natural causes. A remarkable abundance of a species for a term of years is not infrequent, but soon it relapses into its former paucity and harmlessness before the attack of hosts of parasitic foes, which its great increase invites.

Not so, however, with the *Orgyia*. Its conspicuous ornamentation and its assemblage in large numbers render it an attractive object and easily to be discovered by its enemies, and already, as stated, seven different species of insects are known to prey upon it. Scores of the smaller ones (*Chalcididæ*), are often feeding in company within the body of a single caterpillar, and it sometimes seems as if almost every cocoon gave forth the parasite instead of the moth. And yet the

destructive caterpillar abounds, and continues to extend its range and to increase its injuries.

That the present attitude of this insect is so different from that which it formerly held, and which it had assumed, doubtless, many years ago* in conformity to a prevailing law of adjustment in nature, by which each creature eventually becomes fitted to the place it holds — cannot but be the result of some disturbing element operating upon it. Nor can there be any reasonable doubt of what this interference has been.

The English Sparrow the Cause of the Increase.

The extraordinary increase of the *Orgyia leucostigma* is owing to the introduction and multiplication of the English sparrow, *Pyrgita domestica.*

This may seem a strange statement to many, in consideration of the fact that the sparrow was imported from Europe for the express purpose of abating the "caterpillar nuisance" in New York and some of the New England cities.

In the year 1866, two hundred sparrows were brought over from England, and released in Union Park, New York. In 1867, forty pairs were imported and set free in New Haven.

It is claimed in behalf of the sparrows that they accomplished the object of their introduction, and that within two years, they arrested the "measuring-worm plague," which had for years prevailed in the streets and parks of those two cities. They may have done so.† If it could be shown that they rendered this service — perhaps the only good that they have done — it would be insignificant in comparison with the harm they have subsequently caused — even if compared alone with the protection given by them to the *Orgyia.*

In substantiation of this charge, we present some notes of personal observations made in Albany, during the year 1872, which might doubtless have been supported by similar observations in many other localities.

From the rapidity of multiplication natural to the English sparrow, and from the encouragement extended to them by our citizens in providing cages for their shelter and food during the winter, they have become quite numerous. In several quarters of the city where they have

*It is a native species, named and described in 1797.

†A correspondent of the *Rural New Yorker*, in the issue for January 23, 1875, says: "At the very time of their introduction into New York City and Brooklyn, a small ichneumon fly had already lessened the number of span-worms which were so disagreeably abundant in these cities, and it is very probable that the insects would have disappeared without the aid of the birds."

established themselves, their little flocks are continually before the eye, and their unceasing chatter constantly in the ear, almost to the exclusion of other sounds.

The increase of the *Orgyia leucostigma* commenced and has continued to progress with that of the sparrow.

A remark made to me that the caterpillars had been observed to be very numerous in localities where the sparrows also abounded, induced me to undertake to verify or disprove the idea that had suggested itself to me, that the sparrow afforded actual protection to the caterpillars, and promoted their increase.

In a locality in the city (intersection of Broadway and Spencer streets), which I had traversed daily during the preceding year, I had been interested in watching the habits of a large company of sparrows which had established themselves in quarters evidently in every way suited to their taste and wants, among the vines and leaves of a large woodbine (*Ampelopsis quinquefolia*) which covered with a dense matting nearly the entire side of a large dwelling. Here I had observed a greater number of the sparrows than elsewhere in the city: they were still local, and far from being generally distributed.

Upon visiting this locality for the purpose above mentioned, I found upon the other side of the building and on an adjoining one, three other large woodbines not before noticed by me — making five in all. On a tall pole standing between the two buildings, a very large sparrow house, with many compartments, had been erected, and many smaller ones had been placed among the branches of the trees. The woodbines seemed alive with the sparrows: hundreds were issuing from them and dropping down to their favorite stercoraceous repasts in the streets, and the air was vocal with their chattering. It was a rare bird-exhibition. Here certainly was a test-case of the "insectivorous nature" of the sparrow.

On the sidewalk in front of the two buildings, two large, spreading elms (*Ulmus Americanus*) standing between some maples, showed every leaf eaten from them, disclosing the nesting-boxes among their branches, and their trunks and limbs dotted thickly, or clustered with the easily-recognized egg-bearing cocoons of the Orgyia. Hundreds of immature caterpillars were traveling over the trees, fences, and the walls adjoining. No better evidence of the almost perfect immunity afforded to the caterpillars from their enemies — whether birds or insects — by the presence of the sparrows, could possibly be given.

A portion of Broadway, between Clinton avenue and the Central railroad crossing, was also known to abound in the sparrows, the citizens

resident there having fed them most generously, not only during the winter season, but also in the summer months. Nesting-boxes had been placed for them in most of the trees. Here the trees presented a pitiable sight. Many of the elms and horse-chestnuts were entirely stripped of their foliage — the naked ribs of the leaves of the latter seemed ghastly in their suggestion of fleshless fingers. Nowhere else in the city had I seen such ravages.

Passing thence to Pearl and State streets, the same association of sparrows, caterpillars, and their destructive work was seen. Clinton square, where the sparrows had, in their introduction into the city, been specially taken under the care and protection of the residents on the east side of the park, afforded another excellent "test." It was evident that the sparrows were in full appreciation of their privileges, from the almost incredible number sporting among the trees. Their protégés were also in full force. Caterpillars and their cocoons met the eye everywhere, while hanging from the rails and caps of the iron fence surrounding the park were the dead and decomposing bodies of caterpillars, killed by the recent heavy rains (often so fatal to insect larvæ), in such numbers that they tainted the air in their vicinity.

It seems unnecessary to extend this record farther than to add that in other sections of the city, observations made, were in accord with the above.

How the Sparrows protect the Caterpillars.

That the sparrows decline to eat the Orgyia caterpillars is not a charge against them: they *could not* eat them with impunity; the diet would doubtless prove fatal to them. The charge to which they are amenable is this: By the force of numbers united to a notoriously pugnacious disposition, they drive away the few birds that would feed upon them. Of these we know but four species, viz.: The robin (*Merula migratoria*), the Baltimore oriole* (*Icterus galbula*), the black-billed cuckoo (*Coccygus erythropthalmus*), and the yellow-billed cuckoo (*Coccygus Americanus*). The above species seem, in the ordering of nature, to have been assigned to us for protection from an undue multiplication of a large number of hairy caterpillars of injurious habits. While the naked ones are a tempting morsel to most of our insectivorous birds, they instinctively reject the others, the hairs of which would fill their stomachs with a mass of irritating and indigestible material. As we often discover in the animal kingdom special provisions for the accomplishment of certain purposes — as for example, the crossed mandibles of the cross-bill

* This bird has been seen with its head thrust into the web-nest of the tent-caterpillar, eagerly devouring its occupants.

(*Loxia leucoptera*), fitted for tearing open the cones of hemlock and pines for extracting their seeds for food — we may presume that the above-mentioned birds are enabled, through some peculiar structural feature, to appropriate the food that others are compelled to reject. One of them, the yellow-billed cuckoo, is known to shave off the hairs of the *Orgyia leucostigma* caterpillar before swallowing it. The following account of the operation is from Dr. Le Baron, former State Entomologist of Illinois: "My attention was attracted to a cuckoo regaling himself upon these caterpillars which were infesting, in considerable numbers, a larch growing near the house. My curiosity was excited by seeing a little cloud of hair floating down upon the air from the place where the bird was standing. Upon approaching a little nearer, I could see that he seized the worm by one extremity, and drawing it gradually into his mouth, shaved off, as he did so, with the sharp edges of his bill the hairy coating of the caterpillar and scattered it upon the wind" (*First Report on the Insects of Illinois*, 1871, p. 17).

Preventives and Remedies.

A relentless war upon the English sparrows.— If the protection of the Orgyia by the sparrow has been shown, as we believe, beyond question, it follows that, with the abatement of the sparrow plague, the ravages of the caterpillar would be arrested, or very greatly reduced. In view of the magnitude of these injuries to our shade and fruit trees, I do not hesitate to recommend, as a preventive measure, the removal, from among us, of the English sparrow. It would also serve to diminish the losses annually sustained in our orchards, forests and gardens, from the following well-known noxious species: The apple-tree tent-caterpillar (*Clisiocampa Americana*), the forest tent-caterpillar (*Clisiocampa sylvatica*), the fall web-caterpillar (*Hyphantria textor*),* the yellow-necked apple-tree caterpillar (*Datana ministra*), the yellow woolly-bear (*Spilosoma virginica*), and many others of the kind.

As means toward the desirable removal of this intruding protector of injurious insects, the "*ineligibility*" of which in this country has been clearly shown by high ornithological authority,† the following may be suggested: Removal of all nesting-boxes; destruction of their nests;‡ depriving them of shelter and nesting beneath the cornices of buildings

* For its increasing abundance in Washington, D. C., see *American Naturalist*, Sept., 1881, xv, p. 747.

† See Dr. Coues on "The Ineligibility of the European House Sparrow [*Passer domesticus*] in America." *American Naturalist*, August, 1878, xii, pp. 499–505.

‡ Under the existing laws of the State of New York, this is only permissible under certain circumstances. It is hoped that all restriction will be removed by the present Legislature, through a proposed amendment to our game laws.

by wiring over all available openings; using them for food, they being already an article of sale in markets, and said to make an excellent pie; employing the most efficient means to prevent their living in grain-fields, where their intrusion forfeits their lives* (not protected by law). Still another means has been reported to me as having been resorted to under the provocation of great annoyance and large losses — feeding with food prepared with some anæsthetic, *permanent* in its effects.

Destruction of the Orgyia eggs.— An effectual means of prevention of the Orgyia injuries, so far as it can be resorted to, is the destruction of its eggs. This may be accomplished, to a great extent, by a moderate expenditure of labor. The egg-deposits are conspicuous objects, and at once attract the eye looking for them, until, after long exposure, they become weather-worn and lose their original whiteness. Even then they are not difficult to find, as the cocoons upon which they are placed often occur in patches of a dozen or more. A favorite location for them is where a limb has been cut from a tree and a convenient angle afforded by the overlapping growth of the sap-wood. As many as fifty egg-bearing cocoons have been gathered from a single tree-trunk while standing on the ground, the eggs of which represented twelve or fifteen thousand caterpillars.

The month of August would be the most favorable time for collecting the eggs from the trunks and larger branches of trees, they being more conspicuous at that time than later. Those out of arm's reach could be removed by poles or scrapers prepared for the purpose.

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* The sparrow has increased greatly during the last ten years [in England]; great packs of them swoop down on the wheat-fields, *destroying more than they consume*, spilling it over the ground. Every piece of wheat that I saw this year has had more corn [wheat] destroyed by sparrows than would pay one rent at least. * * * If there are as many sparrows in other parts of the country as there are in Lincolnshire, most certainly *one million pounds sterling* would not repay the occupiers of the land for the yearly loss sustained by the depredations of this most quarrelsome pest. * * * They prevent the increase of swallows, and have literally driven all our soft-billed insect-eating birds from our gardens and orchards. The fly-catcher has gone; also the tree-creeper, the peep, the minor warblers, most of which lived on the eggs of moths and butterflies. * * * They were found to be feeding upon turnip seed * * * to be eating red clover seed * * * for two weeks they ate buds of fruit trees. * * In August, just when the grain begins to ripen, they assemble in vast flocks, and soon commit sad havoc in fields of wheat, oats and barley. * * * A field of wheat near Isleworth was so utterly ruined by legions of the sparrows which swarm amongst the neighboring villas, that it was left uncut. (*Report of Observations of Injurious Insects*, by Eleanor A. Ormerod, 1884, pp. 40-42.)

Such will probably be the habits of the sparrow when it shall have spread over the agricultural districts of the United States (at present preferring the larger cities), unless a war of extermination be soon commenced, and continued under the encouragement of liberal bounties offered for their heads.

In England, at the present time, farmers are resorting to poison as an easy way to reduce their numbers, and Farmers' Clubs are paying from 3d to 6d per dozen for old or young sparrows or their eggs.

In a communication to the *Albany Evening Journal* of August 13, 1881, the following recommendations were made by me :

1. That each householder charge himself with the duty of the collection and destruction of these egg-masses upon his own premises. The children of a family will prove ready collectors, especially if encouraged by competition or the offer of a small reward.

2. That the authorities in charge of our public grounds direct the performance of the above duty.

3. That the chief of police direct that the police of the city call attention to its performance whenever they shall observe its neglect, and that this action be authorized by a resolution to that effect by the common council.

4. That the collection and destruction of the cocoons of this insect *be confined to those bearing the white egg-masses*, as all others are those of males, or of ichneumonized [parasitized] females, which may be of great service in developing parasites to aid in the work of extermination.

5. That further search be made for the eggs late in the season, when the absence of leaves will permit their detection on limbs and branches where they may not now [in August] be seen.

Most of the cocoons bearing the egg-clusters will be found upon the trees or shrubs upon which the larvæ feed, where they were placed through the instinct of the caterpillar, in order that the young brood, upon hatching, would not have to travel beyond their feeble strength in search of food. The male caterpillar, with no provision of the kind to make, may wander elsewhere in search of shelter, on the edges of overlapping clap-boards of dwellings, beneath the boards and rails of fences, caps of fence-posts, copings of any kind, window-sills, or in any convenient nook. These need not be destroyed, for, upon being opened, they will be found tenantless or, still better, to contain parasitic pupæ.

Jarring.— When the egg-gathering has been neglected and the caterpillars are discovered destroying the foliage of trees of moderate size, as are many of our fruit trees, a sudden jar will bring them down, and if sheets are first spread beneath, they can readily be gathered up and destroyed.

Paris green.— When operating upon larger trees, the caterpillar may be destroyed by showering with Paris green in water. With a force-pump of good construction, the upper branches (usually the first to be attacked, as the larva is noted for its climbing propensity) of many of the horse-chestnuts can be reached from the ground. When the larger elms are infested it will be necessary to ascend the tree by the aid of a ladder and distribute the liquid from the principal branches. The Hydronette, made by Messrs. Rumsey & Co., of Seneca Falls, N. Y., and

figured in my first report (page 29, fig. 8), will be found convenient to use in connection with a pail of the mixture hanging upon the left arm. When the mixture is to be employed in this manner, the stirring necessary to prevent the settling of the Paris green would be rather inconvenient, and it would, therefore, be better to substitute London purple, which remains suspended for a longer time in water. A half-ounce of the purple to a pailful of water, or the somewhat stronger mixture of a half-pound to the barrel could be used for the purpose.

Cotton bands.— Bands made of loose cotton batting placed around the trunk, at arm's reach or higher, have become quite popular in some of our cities, as a means of preventing the Orgyia attack. Their indiscriminate use must be condemned. They may be of service, and they may be decidedly objectionable. From what has been written of the natural history and habits of this species, it will be seen that the attack, in almost every instance, proceeds from the *eggs deposited the preceding year upon the tree.* If, therefore, the tree is of so small a size as to admit of its thorough inspection throughout and the certainty that no egg clusters are upon it (which could rarely be attained), then a band applied would prevent the caterpillars which may be wandering in search of food from ascending its trunk and feeding upon the leaves. But if the eggs or the young larvæ are already upon the tree, the band will prove a positive evil. In the event of the caterpillars having so thinned the foliage that a better feeding ground is desired, the cotton barrier encountered in their attempted migration would turn them back to resume and complete their destructive work. With even fewer numbers upon the tree, the barriers would prevent the mature caterpillars from descending to the rougher bark of the lower part of the trunk, in the crevices of which they prefer to build their cocoons, and would confine them to the branches, where it would be difficult to discover the egg-clusters, and to reach them for their destruction as previously recommended.

A New Form of Orgyia Attack.

In the summer of 1883, contemporaneously with the first appearance of the *Orgyia* attack upon the foliage, between the 10th and 15th of June, the sidewalks, streets and public parks in Albany, wherever the white elm (*Ulmus Americanus*) was growing, were observed to be sprinkled with newly fallen leaves. They continued to drop in increasing number until toward the close of the month, when, in many places where they had been permitted to lie undisturbed, they completely covered the walks or ground.

Upon taking some of them up for examination, they were found to be attached to the tips of the twigs and to comprise nearly all of the new

Fig. 11.

Fig. 13.

growth of the season. The pieces were from two to three inches in length, each bearing from four to ten fresh uninjured leaves. It was evident that they were not being broken off by unusually high winds, for even in the absence of winds, each day continued to add to their number and to increase the abundance of the fall.

Making critical observation for the discovery, if possible, of the cause of so unusual a phenomenon, it was noticed that from above the point at which the tip had been broken, the bark was entirely removed for an extent averaging one-tenth of an inch, presenting the appearance shown in Fig. 11. The manner of its removal showed it to have been eaten by an insect. The suggestion was made to me that it was the work of some small insect of similar habits to those of the twig-girdler, *Oncideres cingulatus* (Say), but the closest examination failed to show either scar or egg within the tip.

From the character of the injury, together with the abundant presence of the caterpillar upon the trees at the time, and of no other observed depredator, I believed that it was the work of the *Orgyia*. If so, it was of especial interest, as showing a new habit developed, for this form of attack had never been recorded of the insect. To verify the belief, after ascending some trees and examining branches within reach from windows, I went upon a house-top, where the limbs of a large elm, projecting over the roof, gave an excellent opportunity for examination. The larvæ were abundant upon the tree ; the flat roof was strewn over and heaped in corners with the broken-off tips; very many girdled tips still held their place on the tree ; and after careful search, Orgyia larvæ were discovered in the act of eating the bark at the girdled points. From later observations, it appeared that the girdling had at this time nearly ceased.

The following explanation of the cause of the falling of the girdled tips seems a rational one. Upon the eating away of the bark by the Orgyia caterpillar, the wood rapidly dried from its exposure to the air and arrest of circulation, and soon became so brittle that from a moderate swaying of the branches, the weight of a half dozen or more of large succulent leaves would occasion the breaking-off of the slender twig — often not exceeding, in its dried state, the diameter of an ordinary pin.

For the occurrence at this time of this novel form of Orgyia attack, I can only offer the following as a plausible explanation : The spring had been remarkably cold, and as a consequence, the development of the foliage had been delayed to quite beyond the ordinary time. The sudden advent of warm weather caused a corresponding sudden start in vegetation, followed by a vigorous growth, and the young tips of the

elm would, as the result, be unusually tender. The particular feeding ground of many of the lepidopterous larvæ is known to be selected only after repeated tastings and rejections of such portions of their food-plant as they traverse, and a final acceptance of that most agreeable to them. By a process like this the Orgyia may have made the discovery, that just at the commencement of the new growth, as the result of the seasonal conditions above mentioned, there was concentrated in the tender bark nutriment far more acceptable to it than that offered in the leaves, upon which alone it had hitherto been accustomed to feed. As the bark hardened with the advancing season, it would cease to be desirable for food.

During my absence from the city for most of the months of July and August, the following observations upon the falling tips and the Orgyia were made, at my request, by Mr. W. W. Hill:

July 6. Tips of four to six leaves falling, larvæ — some spinning.

July 10. Many larvæ spinning — a female moth ovipositing.

July 11. A few tips observed.

July 12 and 13. Tips falling fast after a heavy rain — moths ovipositing.

July 14–21. Tips falling — male and female moths observed.

July 22–31. Larvæ, cocoons and moths — many tips falling.

Aug. 1. Larvæ, cocoons and tips observed.

Aug. 2–11. Tips falling, but no larvæ or moths seen.

Aug. 18. Tips still falling.

On my return to Albany for a few days, on the 21st of July, most of the tips then falling and many of those upon the ground presented a new feature. The breaking, instead of being at the base of the girdling, just above the commencement of the new growth, was, in these, at the preceding node, covering the growth of the former year, as represented in Fig. 12. As a rule, the twigs showed a greater diameter at their decorticated portion, compared with those of the earlier fall, and the leaves attached to them had been all more or less eaten by the Orgyia. Their greater strength had permitted them to remain longer upon the tree, and until the death of the preceding internode, which soon followed the arrest of the circulation — its starvation ensuing — it being unprovided with leaves through which a circulation could still be maintained. When dead, a slight movement of the branch by the wind, or even the weight of the terminal leaves would be sufficient to disconnect it at its lower and weaker node. In a few instances, as shown in Fig. 13, where the girdling had been at a little distance above the node marking the commencement of the present year's growth, the separation had been at this point, while others separated in this manner, instead of the

Fig 12.

Fig 14.

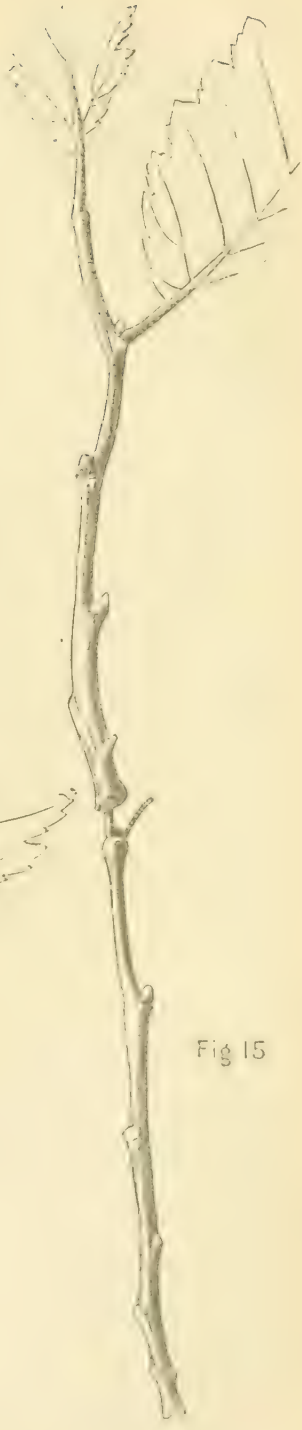

Fig 15

narrow girdling band, had had the bark irregularly removed for the extent of an inch or more, as in Fig. 14. All of these later falling twigs showed the interval that had elapsed between the injury and the fall, in that the roughened edges of the bark left by the gnawing had healed over with the peculiar roughened and rounded enlargement following the deposit of the reparative material under such conditions. Some of the twigs gathered gave excellent illustration of the ascent of the sap through the outer wood, and its return, after assimilation in the leaves, through the inner bark. In one instance, where the leaves were unusually large, the descending sap, arrested at the girdled point, had built up structure in the tip until its diameter was more than double that of the starved internode below, while the immediate point of the arrest was quite enlarged from the material there deposited, as shown in Fig. 15.

This peculiar attack did not extend to the other principal food-plants of the Orgyia, as the horse-chestnut, maple, apple and plum, nor would it be expected to occur in connection with growth and structure so different from that of the elm.

The same attack upon the elms, and to about the same extent, was noticed by me in Troy, N. Y., six miles north of Albany. It has not been reported elsewhere, although it probably extended to other localities where the Orgyia abounded under similar climatic conditions. It was not observed in the city of New York, although the caterpillar was very abundant there, and through its excessive ravages, attracted great attention, as has been already referred to.

Plusia brassicæ Riley.

The Cabbage Plusia.

(Ord. Lepidoptera : Fam. Noctuidæ.)

Riley: 2d Rept. Ins. Mo., 1870, pp. 110–112, f. 81 (orig. descr. and notice); American Entomol., iii, 1880, p. 200 (cannibalistic habits); Ind.-Suppl. Mo. Repts., 1881, pp. 77–8 (descr.); in Papilio, i, 1881, p. 106 (differences from *P. ni*); id., ii, 1882, p. 43 ; in Rept. Commis. Agricul. for 1883, pp. 119–122, pl. 1, figs. 2, 2a, pl. 11, f. 2 (habits, nat. hist., remedies, etc.).

Thomas : 7th Rept. Ins. Ill., 1878, p. 229 (habits and descr.); 9th Rept. do., 1880, p. 40 ; 10th Rept. do., 1881 (figs. from Riley, brief descr. of larva).

Grote : in Bull. Buff. Soc. Nat. Sci., i, 1873, p. 147 (as *P. ni*) ; id., ii, 1875, p. 30 (catalogued as *P. ni*) ; in Canad. Entomol., vii, 1875, p. 205 (as *P. brassicæ*); in Papilio, i, 1881, p 127 (may be *P. ni*).

Bethune : in Rept. Ent. Soc. Ont. for 1871, p. 5, f. 93, 1872 (from Riley).

Packard : in Hayden's 9th Rept. U. S. Geolog.-Geograph. Surv. Terr., 1871, p. 752, figs. *a*, *b*, *c* (from Riley).

SPEYER : in Stett. Entomolog. Zeit. for 1875, pp. 165, 166 (compared with *P. ni*).
LINTNER : in Colvin's 7th Rept. Surv. Adiron. Reg. N. Y., 1880, p. 399 (as *P. ni*, visiting flowers in Ill.); in Count. Gent., xlvi, 1881, p. 711 (general notice); 1st Rept. Ins. N. Y., 1882, pp. 65, 156 (remedy and parasite).
HOWARD : in Bull. No. 3, Div. of Entomol.— Dept. Agricul., 1883, p. 20 (effects of pyrethrum on larvæ).

The increasing destructiveness of this insect within the past few years has brought it prominently into notice, and in response to the many requests made for information in regard to it, its natural history has been ascertained and published, together with the means by which the excessive injuries from it, threatened, may be largely averted.

Examples of the larvæ, pupæ and the moths were received from Dover, N. J., during the latter part of October, with the statement that they had been for some time past, and still continued to be, very destructive to cabbages and Swede turnips, defying the remedies with which the larvæ of the cabbage butterfly, *Pieris rapæ*, had been successfully combatted. The moths had been observed depositing eggs upon the cabbage soon after sunset. It was desired to know if they were an old or a new enemy, and if it was probable that they would continue to be formidable, or were they developed in their present numbers by the recent heat and drouth.

Description.

Larva.— The caterpillar, shown at *a* in Fig. 15, is of a pale-green color, delicately lined in white, with some small white spots, each of which bears a short hair, usually blackish. The head is small, flattened and shining. The body is slender, deeply constricted at the joints, gradually increasing in size from the head to the eleventh segment, where it is rapidly contracted and slopes abruptly to the pair of contiguous anal prolegs: besides these, there are two other pairs of prolegs, and the three pairs of true legs. Its length at maturity is nearly one inch and a quarter.

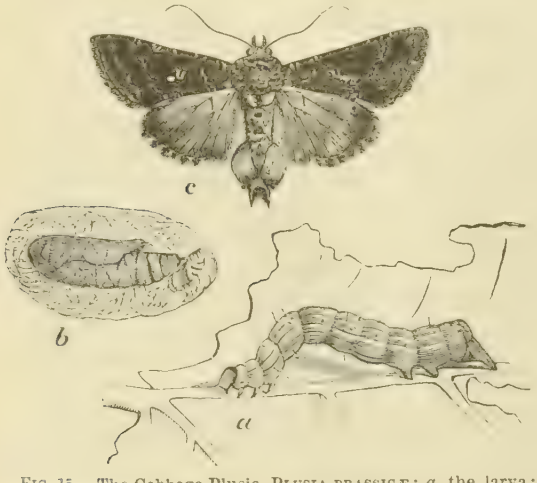

FIG. 15.—The Cabbage Plusia, PLUSIA BRASSICÆ: *a*, the larva; *b*, the pupa within the cocoon; *c*, the male moth.

The method of walking of these caterpillars is rather unusual among the *Noctuidæ*, in that they loop the body after the manner of

the "measuring worms" or "geometers" of the *Geometridæ*, as represented in the figure; but unlike most of the geometers, they are tapering, and not cylindrical throughout. This motion is the consequence of their being unprovided with prolegs on the sixth and seventh segments — having only three pairs of abdominal legs instead of the usual number of five.

Pupa and moth. — The chrysalids or pupæ into which the larvæ transform are contained within loosely-spun silken cocoons, permitting the pupæ to be seen through the threads, as shown at *b*. Several of the larvæ received were spinning their cocoons October 25th, while others were apparently but about half-grown. The pupæ are of a light yellowish or green color, with a projection on the central portion of the lower side, indicating the unusually long proboscis of the moth, for which provision is made in its extended case.

The front wings of the moth are dark grey, almost brown ; the indistinct transverse lines are pale yellowish ; the more conspicuous markings are two small silvery spots near the center of the wing, either united or close together, of which the outer one is oval and the inner U-shaped. The hind wings are smoky outwardly, and yellowish toward the base. The expanse of wings is about one inch and a half.

The male moth shows a peculiar feature in two tufts of fawn-colored hairs, which spring from the sides of the abdomen behind the middle, and meeting on the back. In the figure of the moth, at *c*, this feature has been given unusual prominence, in comparison with the examples seen by me.

For the detailed description of the moth, which might be required for its separation from some closely resembling species, when captured elsewhere than in connection with its larva or general food-plant, reference may be made to its original description in the 2d Missouri Report, pages 111–12.

Food-Plants.

The insect has become a well-known cabbage pest, and its specific name indicates its favorite food-plant, upon which it usually occurs, but it is far from being confined to the cabbage. Its list of food-plants is being continually extended as the result of further observations, and already it embraces kale, turnip, tomato, lettuce, celery, mignonette (*Reseda*), dandelion (*Taraxacum*), dock (*Rumex*), *Crepis*, *Chenopodium*, clover (*Trifolium*), German ivy (*Senecio scandens*), Japan quince (*Cydonia japonica*).* It seems to have developed a particular fondness

* Riley : *Rept. Comm. Agricul.* for 1883, p. 119.

for celery, as it is reported as having nearly destroyed a celery patch near Bladensburg, Md.

Distribution and Injuries.

The species occurs in most of the Middle, Southern and Western States, from New York along the Atlantic States, the Gulf States, and the Mississippi valley States to Missouri and Illinois. In the Southern States its injuries to cabbages are quite severe. Its depredations are seldom serious in the Middle States, except in times of drouth and continued hot weather, which seem almost essential to its presence. It has never, to my knowledge, occurred in New York in numbers capable of inflicting much harm, and indeed the moth is regarded as a rarity by our collectors. Within the last five years several of the moths have been captured near Albany, and it is not improbable that the species, as in the case of the harlequin cabbage-bug, *Murgantia histrionica*, may be gradually working its way northward and adding to its permanently occupied territory. It does not yet appear in careful lists of Lepidoptera occurring in the State of Maine. It has been recognized among collections made in California.*

Its Resemblance to an European Species.

It approaches so nearly to an European species, *Plusia ni* Hübn., that its specific difference has been questioned and given occasion to considerable discussion among some of our writers. But as Dr. Speyer, a distinguished Prussian entomologist, whose studies of the allied forms of Lepidoptera in Europe and America have been so critical and just as to have been generally accepted, has carefully compared the two, and believes them to be distinct forms, they are so received, at present, by our leading entomologists.

Number of Broods.

In its more northern extension there are two annual broods, for, from larvæ taken in August, after about two weeks of pupation, Dr. Thomas has had the moths emerge on the 1st of September, which deposited their eggs for a second brood in October. In the Southern States there are probably four broods, for Mr. Grote took examples of the moth in Alabama, during the last of February. Some of the European Plusias are recorded as having three broods a year, although most of them are believed to be single-brooded.

*It is reported as appearing, in 1884, in Ramsey and Hennepin counties, in Minnesota, and proving almost as injurious to cabbages as the white cabbage butterfly *Pieris rapæ* (O. W. Oestlund).

Cannibalistic Habits.

An instance has been given by a correspondent of the *American Entomologist*, where this species manifested a cannibalistic propensity. Two of the caterpillars having been inclosed in a box with two of those of the cabbage butterfly, *Pieris rapæ*, and three of another cabbage pest, *Pionea rimosalis*, upon opening the box three days thereafter, it was found that the Plusias had killed and eaten all the others. Should this love for its kind develop into a habit as strong as that existing in the corn-worm, *Heliothis armiger* (see First Report, pages 119–120), it might become serviceable in reducing the number of its associate depredators on the cabbage.

Remedies.

When not extraordinarily abundant, this insect may be kept in check by a moderate amount of labor expended in hand-picking; for as the caterpillars usually rest with their body looped in Ω-shape, they are conspicuous objects, and may be readily discovered and gathered. They may also be destroyed by sprinkling the plants with hot water, of a temperature not exceeding 150° Fahr., if applied through the nozzle of a common sprinkler; but if distributed in the finer spray of the rose of a force-pump, a temperature as high as 170° should not injure the leaves. But probably the best application, the easiest and the most satisfactory, would be that of pyrethrum. A tablespoonful of good fresh powder, diffused through two gallons of water and sprinkled over the plants, would destroy the larvæ — the more quickly if employed while they are still immature.

A preventive measure that would amply repay the effort would be to capture the moths when they are abundant, in a net, as they hover about the plants at dusk in readiness for the deposit of their eggs. That they are so abundant at times as to be easily captured in this manner is evident from the statement made by a gentleman from the District of Columbia, in commending this method, that in a long-continued drouth "*the moths came in swarms*, and afterward come the worms." Catching the moths in their peculiar flight could easily be made a pleasant pastime for the children of a family, while it might serve the additional purpose of leading them to the fascinating study of the habits of the insect world. So simple a thing as an insect net, might thus, under proper direction, become one of the most important of household implements.

Plusia dyaus Grote.

(Ord. Lepidoptera: Fam. Noctuidæ.)

Grote : in Canadian Entomologist, viii, 1875, pp. 203–4.

Several of the caterpillars of this beautiful moth were received in the month of February, from Dr. R. H. Sabin, of West Troy, N. Y. They had been taken from his conservatory, where they had been proving quite destructive to a number of the plants. They had first been discovered upon a heliotrope which was nearly destroyed before the attack was noticed. They were picked off by hand and killed, as they were of large size — about an inch in length — and readily found, both by the eaten leaves and the masses of excremental matter adhering to the foliage below them. Subsequently others were discovered, feeding quite as greedily upon different species of *Geranium*, brookmansia, easter-plant (*Eupatorium ageretoides*), stevia, etc. They seemed especially fond of the Wandering Jew (*Tradescantia*), the succulent leaves of which were rapidly consumed with evident relish.

The insect had never before been observed by Dr. Sabin, nor, indeed, any such formidable mid-winter attack in his conservatory — the season in which we naturally expect to enjoy immunity from insect ravages.

The Caterpillar.

The caterpillars were innocent-looking creatures, with their small head and attenuated form, in their pale-green garb, delicate white linings and transparent skin, through which the pulsation of the dorsal vessel (the heart) was plainly to be seen. Their peculiar looping movement in walking is like that of *Plusia brassicæ*, as all the species of the genus *Plusia* are provided only with six pairs of legs in lieu of the normal number among the *Noctuidæ*, of eight.

As the caterpillar has not been described, the following detailed description of it is given :

Length at maturity, from 1.3 to 1.5 of an inch ; regularly increasing in size from the head to the penultimate segment. The head is round, flattened in front, and of a shining apple-green color ; the mandibles are black-tipped ; the labium pearly white ; the clypeus transparent, disclosing internal organs; the ocelli are black. A few hairs are observable upon the sides of the head which are nearly as long as its diameter. The breadth of the head is about one-fourth that of the eleventh (the broadest) segment, and nearly equal to that of the first.

The body is clear apple-green in color upon the sides and beneath,

and whitish-green over the back. The dorsal vessel is apple-green with its borders well-defined by white lines, contracted at the incisures and considerably enlarged centrally upon each segment. Below the dorsal vessel is a whitish shading, inclosing the anterior of the trapezoidal spots, and extending nearly to a pale whitish-green subdorsal line which is angulated on each segment beneath the posterior trapezoidal spot; there are also two lateral similar colored lines above the spiracles, the lower of which runs nearly straight, while the upper one is quite toothed or crinkled. The spiracles are of a pale orange color. Each of the usual piliferous spots bears a pale-colored hair of the average length of one-fourth the diameter of the body. In addition to these, there are a number of corneous yellowish dots scattered, or grouped in short rows, upon the sides. The body slopes abruptly from the crown of the eleventh (penultimate) segment to the anal pair of prolegs. The legs are long, watery-green, and transparent; the prolegs are dull green with their plantæ tinged with red.

In one of the examples, the slightly elevated piliferous spot above the spiracle on each segment, is black, as are also all of the like spots on the head, of which there are four conspicuous ones arranged in a rhomboid. All of the setiferous spots of the first segment are also black, as are the two dorsal ones on segments two and three; those on segment eleven are annulated with black.

The caterpillar is a rapid and seemingly a greedy eater, and is not easily disturbed when feeding. Its large excremental pellets are distributed over the leaves to which they adhere. At times it assumes the favorite position of many of the *Geometridæ* when at rest. Sustaining itself with its prolegs, it elongates the detached portion of its body and extends it at a considerable angle with the leaf or stem — the three pairs of true legs scarcely visible from being folded upon one another and upon the body and directed forward in range with the head similarly projected.

Transformations.

The larvæ were brought to me on February 10th, when they were nearly full grown. They were fed upon the leaves of the Wandering Jew. Two of the number spun up in slight cocoons made of fine threads within the leaves on the 13th. The cocoons were of so slight a texture as hardly to deserve the name when compared with some of the architectural marvels which many species of caterpillars construct for shelter and protection during their long months of pupation — firm as parchment, double-walled to exclude wet and to regulate temperature, with an accurately adjusted lid in some cases for the escape of the inclosed insect, and with other wonderful contrivances for, and adaptations to, spe-

cial purposes. It consisted only of a few loose silken threads for support and a thin sheet for covering, thrown across and within the upturned edges of a leaf of their food-plant. Through this thin webbing the caterpillar could be seen for two days after the spinning, when, by gradual contraction and finally throwing off the caterpillar skin, it assumed the pupal form. The pupa could be watched day by day growing darker in color as the insect within was taking form and substance, until twenty days had passed, when the beautiful moths, one after another, emerged.

Beauty of the Plusia Moths.

Guenée, in his *Histoire Naturelles des Insectes*, thus discourses upon the beauty of these moths:

The perfect insects are, without exception, most beautiful. Some of them claim our admiration from their satiny plates in bronze or reddish-brown, of which the most conspicuous precedes the terminal border, and reaches, in gradual contraction, the median space behind the basilar line. But the larger number, in addition to these plates which occur with almost all, bear a particular ornament. This ornament consists in one or two spots placed beneath the cell, peculiar to this genus and not answering to any of the three ordinary spots. These spots are colored with a matter which imitates polished gold or silver in color and brilliancy. They are slightly raised upon their borders as if some drops of these rich colors had fallen upon the wing and become depressed in the middle in drying. But, like all the rest of the wing, they are composed of imbricated scales, of which the exterior ones form a hem in rounded outline, instead of being transversely disposed as are all the other scales of the wing, even those which form the metallic portions often as brilliant as are these particular spots.

But it is not only by their brilliancy that these spots are remarkable; it is also by their form, which is not less essential, and which serves us potently in distinguishing the species. Sometimes they are but simple rounded plates, sometimes two contiguous points; more frequently the posterior one has the form of an oval point, while the anterior is shaped like a hook more or less open, resembling a U or a Y, or yet an interrogation point wanting its dot beneath. Finally, the two spots are bound together, and then the posterior sign takes the form of a tear or a drop, and the entire figure represents a *gamma* or a *lambda* reversed. Both of these and other names of letters and characters have been called in requisition for designating the species of the genus *Plusia*, although these alphabetic signs are not always very striking. (*Noctuélites*, ii p. 325–6.)

The Species Doubtfully Named.

I have referred this moth, for the present, to *Plusia dyaus*, in deference to the determination made of it by Mr. Grote, although probably done without comparison with his type or other examples. The differences observable in the specimens in my possession, when compared with a single example of *P. dyaus* (not in perfect condition, it should be stated) have led me to doubt the correctness of the determination.

In that species, the inner silver spot is subrectangular, tending to form the three sides of a square, while in this it is distinctly rounded where it connects with (or almost touches in one example) the outer tear-shaped character; the two together having much the appearance seen in *Plusia ou* and *Plusia precationis*. The inner transverse line is more nearly straight in this in its course from the inner margin; and there are other differences that need not now be indicated.

Mr. J. B. Smith, whose careful studies have made him our accepted authority upon the *Noctuidæ*, to whom I have submitted an example of the moth with the request that he would pronounce upon it, has returned answer that it is not *P. dyaus* and that he cannot satisfactorily identify it with any species; but, in consideration of the differences in the determinations of the Plusias in different collections, he would not like to pronounce definitely upon it until after study of the types of all the doubtful forms.

If, upon further study, the present form proves to be new to science, I would propose for it the name of *Plusia culta*.

Amphidasys cognataria Guenée.

The Currant Amphidasys.

(Ord. Lepidoptera; Fam. Geometridæ.)

Guenée: Hist. Nat., Ins.-Lep., ix, 1857, p. 208, No. 312.

Walker: List Lep. Heteroc. Brit. Mus., 1860, xxi, p. 307.

Packard: Guide Stud. Ins., 1869, p. 322 (brief notice); Mon. Geomet. Moths, 1876, p. 413, pl. 11, f. 4 (of moth).

Bowles: in Canad. Entomol., iii, 1871, p. 11 (descrip. of stages).

Saunders: in Rept. Ent. Soc. Can. for 1871, p. 38; Ins. Inj. Fruits, 1883, p. 349–50, f. 363 (of moth).

Lintner: in 26th Rept. N. Y. St. Mus. Nat. Hist., p. 166 (larva descr.); in Count. Gent., xlvii, 1882, p. 785 (on apple tree).

The popular name given to this insect of the "Currant Amphidasys" is in consideration of its having been found to be more destructive to the currant than to other of the food-plants upon which it occurs. On one occasion a small black currant bush was observed as presenting a peculiar appearance, as if only the bare stalks of the leaves were remaining upon the branches. On closer examination the supposed stalks proved to be the bodies of caterpillars of this species, resting in their customary manner, clinging to the branches with their anal legs, and holding their bodies extended (Bowles, *loc. cit.*). Twenty-four of the caterpillars were collected from the one bush.

This species, as appears above, belongs to the family of *Geometridæ*, so called from the peculiar gait that the larvæ have in walking. The larger number have but ten legs (a few have twelve or fourteen) instead of the ordinary number belonging to caterpillars, viz., sixteen; of these, the three pairs of the front segments of the body are placed closely together and the two hinder pairs quite at the other extremity. At rest they clasp the twig upon which they are placed, with the two terminal pairs of prolegs, extending the body rigidly outward at an acute angle with the twig, with the front legs folded so closely together and against the head as not to be visible. In this attitude they are scarcely to be recognized as living objects. Their obscure colors and some rugosities of surface make them resemble closely a piece of dried twig, for which they are often mistaken. In walking, the head is brought downward, and the branch is seized by the front legs. The body is then arched upward in a loop like the Greek letter *Omega*, and the hinder legs brought close to the front ones. The front legs are again thrust forward as far as possible for another grasp, and thus successive spaces are measured off, which are frequently about one inch in length; and from this the name of "inch worms" has been given to them, in addition to "Geometers" and "loopers."

The Caterpillar.

The insect has not, up to the present, I believe been figured in its larval stage, and we therefore take pleasure in presenting a figure of it drawn by Miss Emily L. Morton, of Newburg, N. Y. It is represented as feeding upon the honey-locust, *Robinia pseudacacia*, which in that locality seemed to be its favorite food-plant.

From two of the larvæ, obtained by me in September, nearly full-grown, the following description is taken:

Length 1.6 inch; greatest diameter toward terminal segments, 0.2 inch, gradually tapering thence anteriorly. Head, dull yellowish, subquadrate, but excavated above into two horn-like protuberances (with reddish-brown granulations) which are brown posteriorly. Body, dull

FIG. 16.—Larva of the Currant Amphidasys, AMPHIDASYS COGNATARIA.

brown with a greenish tinge, somewhat bluish laterally and on the last segment. On segments three to seven, a subdorsal white spot on the anterior of each. Collar, along its front edge, with a line of reddish-brown granulations, ending each side in a brown tubercle. On eighth segment, two subdorsal pyriform yellowish tubercles, bearing numerous dark-brown granulations, and on the eleventh segment, two similar more yellowish ones, more approximate and less elevated and with fewer granulations; back of these on the terminal segment, the granulations are whitish. Prolegs upon the ninth and last (twelfth) segment only; the latter pair spread laterally in walking, are bordered behind with short whitish spines, and their extreme hinder portion beneath the anal shield, bears two fleshy horns which come together when moving like a forceps, almost serving as an additional pair of prolegs. Beneath, on segments five, six and seven, each, a yellowish wart, of which the middle one is

the largest. The stigmata or breathing-pores are broadly oval, and bordered with red. A magnifier shows a short blackish hair upon each of the ordinary piliferous spots. The legs are reddish.

The Moth.

The moth is quite unlike the usual slender-bodied and broad-winged *Geometridæ*, having a short and stout abdomen, in which, together with its proportionate spread of wings and their general shape, it strongly resembles many of the *Bombycidæ*. Indeed until its structural characters are studied, it seems quite out of place in an arranged collection of the *Geometridæ*.

Fig. 17, taken from Saunders' *Insects Injurious to Fruits*, gives good representation of the insect. The body and the thorax are gray, the latter with a white collar. The wings are gray, dotted, streaked and lined with black. Two black lines bound the central portion of the wings, the outer one of which is strongly two-toothed on the primaries, and one-toothed on the secondaries. Between these lines, the ground is white sprinkled with black, and traversed centrally by a two-lobed shade on the primaries. The antennæ are broadly pectinated in the male; the abdomen short and quite stout in the female. Expanse of wings, two inches.

FIG. 17.—The Currant Amphidasys, AMPHIDASYS COGNATARIA Guenée.

Life-History.

There are two annual broods of this insect. From larvæ collected in August, I have obtained the imago in the following May. From larvæ taken by Miss Morton on the 28th of June, nearly full-grown, and which entered the ground for pupation on the 10th and 12th of July, the moths were produced from the 12th to the 22d of August. The last of these attracted several males during the night following its appearance, and deposited a large number of eggs on the succeeding night. The larvæ from the eggs were fed upon the honey locust, but being only about one-third grown when the leaves fell, they were not matured. They doubtless died from starvation and exposure in the bag in which they were confined upon a locust, where no suitable shelter could be had, for they were observed traveling about within the bag during all the warmer days of October and November.

Other larvæ taken by Miss Morton during the summer of 1882, buried themselves in the ground, from the 16th to the 20th of September, but failed to produce the perfect insect.

Food-Plants.

In addition to the currant and honey locust and maple above noticed, Dr. Packard records as food-plants of the larvæ, gooseberry, the Missouri currant [*Ribes aureum*], and the red *Spiræa* (*Guide to the Study of Insects*, 1869, p. 322). Miss Morton has also collected it occasionally from horse-chestnut. Mr. William Saunders thinks that it feeds on pine, having captured the moth several times about pine wood, and being also of the impression that he has bred it from the pine (*Rept. Entomolog. Soc. of Ontario*, for 1871, p. 39). In the 23d *Rept. of N. Y. State Cabinet of Natural History*, p. 195, I have recorded taking it upon plum. It has also been sent to me from Wisconsin, as quite injurious to apple-trees, which the caterpillars were represented as killing. That they could have caused the death of the trees upon which they fed, is not at all probable. The belief was doubtless of hasty observation. The gentleman sending them, stated; "Every branch having them on, died. My theory is that they suck the sap from the branch. They did not eat the leaves or branch." After the habit of many of these geometrid larvæ, the caterpillars in the above instance, having satisfied their appetites, had probably left their feeding-ground and traveled to some dead limb where they might elude observation, through their wonderful mimicry of a dead twig. In this position it was perhaps but natural that the inference was drawn that they were the cause of the death of the branch upon which they were found.

Distribution.

This species has broad distribution throughout the northern and western States. It occurs from Maine, throughout the New England States into New York, Pennsylvania, into Ohio (Dayton), Wisconsin (Hoy), and Kansas (Snow). In the Dominion of Canada, it is reported from Quebec and from London.

Remedies.

Many of the caterpillars of this family can be made to drop from the branches upon which they are feeding and hang suspended by their thread, by means of a sudden jar upon the limb, when they can be swept off by a stick and crushed. This species will not often be found in such numbers as to be capable of inflicting serious harm. When it does so, if too numerous for hand-picking, it can be destroyed by spraying the foliage with a kerosene emulsion.

Sitotroga cerealella (Olivier).

The Angoumois Moth.

(Ord. LEPIDOPTERA : Fam. TINEIDÆ.)

——— ——— RÉAUMUR: Mem. Hist. Nat. Ins., 1736, ii, pl. 39, figs. 18, 19; Mem. Acad. Sci. Paris, 1761.

Alucita cerealella OLIVIER: Encyc. Method.—Hist. Nat. Ins., iv, 1789, p. 121.

Œcophora granella LATREILLE: in Cuvier's Règne Animal, 2d ed., 1829.

Alucita cerealella. HERRICK: in Rept. Commis. Pat.—Agricul., for 1844, p. 166.

——— ? ———? JUDAH: in Indiana Farmer and Gardener, for Oct. 4, 1845.

———? ———? RUFFIN: in Farmers' Register, for Nov., 1833 (cited by Harris); in American Agriculturist, for Feb. and March, 1847, vi, pp. 52, 93.

Anacampsis cerealella. OWEN: in Cultivator, N. S., iii, for July and Nov., 1846, pp. 208–212, 344–345 and figures (specific characters, injuries, remedies, etc)

Anacampsis cerealella. GLOVER: in Rept. Comm. Pat.—Agricul., for 1854, pp. 67–69.

Anacampsis cerealella. FITCH: in Cultivator, N. S., iv, 1847, pp. 13, 14.

? Ypsolophus granellus. KIRBY-SPENCE: Introduc. Entomol., 6th ed., 1846, p. 129.

Butalis cerealella. EMMONS: Agricul. of N. Y., 1854, v, pp. 254–5 (descr., habits, remedy).

Butalis cerealella. CHENU: Encyc. d'Hist. Nat.—Noct., 1859, pp. 274–5 (general notice).

Gelechia cerealella. STAINTON: Manual Brit. Moths and Butt., ii, 1859, p. 345 (mention).

Gelechia cerealella. CLEMENS: in Proc. Acad. Nat. Sci., Phila., for May, 1860, p. 158 (description); Id., in Stainton's Tineina N. A., 1872, p. 112.

Butalis cerealella. FITCH: in Trans. N. Y. St. Agricul. Soc., for 1861, xxi, p. 813; 7th Rept. (of 6th–9th Repts.) Ins. N. Y., 1865, pp. 129–133, pl. 1, fig. 2 (extended general account).

Butalis cerealella. HARRIS: Treat. Ins. N. Eng., 1852, pp. 392–402; Treat. Ins. Inj. Veg., 1862, pp. 499–510 (general account); Entomol. Corr., 1869, p. 169 (generic discussion).

Sitotroga cerealella HEINEMANN: Schmett. Deutsch. Schweiz., 1870, Band 2, Heft. 1, p. 287.

Butalis cerealella. BETHUNE: in Rept. Ent. Soc. Ont., for 1871, p. 61 (brief notice).

Gelechia cerealella. FRENCH: in Thomas' 7th Rept. Ins. Ill., 1878, p. 266 (brief mention).

Butalis cerealella. SAUNDERS: in Rept. Ent. Soc. Ont., for 1881, p. 5 (brief mention).

Gelechia cerealella. WEBSTER: in 12th Rept. Ins. Ill., 1883, pp. 144–154 (history, parasites, enemies, etc.).

Gelechia cerealtella. RILEY: in Rept. Commis. Agricul. for 1884, pp. 345, 350, pl. 6, figs. 2, 3.

From Mr. E. H. Ladd, of the New York Agricultural Experiment Station, at Geneva, Ontario county, the following communication was received, under the date of October 27, 1884 :

I send you a half ear of "forty days early" corn containing the larvæ and pupæ of a moth from which the moths are now escaping in the

Museum. Last night these moths came forth from the specimen sent you. Dr. Sturtevant informs me that it has been present the past two seasons at the station. As the specimen of corn sent you shows, should the insect continue to increase it must do an immense amount of damage to the corn of this section in future years. Will you please give me the name of the moth, and something of its natural history; also in what works are to be found the fullest accounts of it.

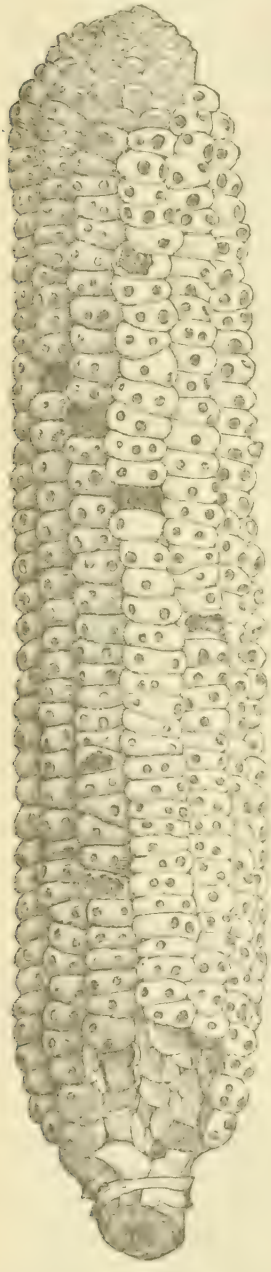

FIG. 18. — Ear of corn showing the work of the Angoumois moth. SITOTROGA CEREALELLA.

The insect was the Angoumois moth — so named from the canton in France, where its excessive ravages, over a century ago first brought it into general notice. It has long been known as an injurious grain insect in the southern and central portions of the United States, but fortunately it has not proved very destructive in the State of New York or in New England. Originally described by Olivier, in 1789, as *Alucita cerealella*, it has been noticed by several of our entomological writers, in later years, under the name of *Butalis cerealella*, and still later, as *Gelechia cerealella*. This latter genus of the *Tineidæ* having been made the receptacle of a large amount of incongruous material, more careful study is withdrawing from it wrongly referred species, and for the Angoumois moth, Heinemann, in his *Schmetterlinge Deutsch.-Schweiz.*, in 1870, established the genus of *Sitotroga*. This genus appears to be accepted by our authorities in the *Tineidæ*.

Three of the moths were in the box received from Geneva, when opened, and others continued to emerge on following days. The piece of corn, about two inches long, contained eight rows, in which were ninety-six kernels. Of these, sixty-four (sixty-six per cent) contained cells of the insect, as shown by the round smoothly-cut opening of a size less than the head of an ordinary pin, through which the moth had emerged, or by the thin, nearly transparent hull of the kernel covering the cell. Only nine of the cells were open, showing that the occupants had barely commenced to emerge. The pupa-cases were left within the cell where

with a magnifier their brown anterior end could be seen. Upon cutting into the kernels, the pupæ were found incased in a delicate silken cocoon, held firmly in place by a packing of the large and yellow pellets of the excrementa which filled the cavity made by the larva. The cavity occupies about one-half of the transverse diameter of the kernel and its entire longitudinal diameter, embracing the germinal portion, beyond which was a mass of the excrementa adhering to the cob. In no instance had a kernel been occupied by more than a single larva, although the amount of food would have sufficed for two or more.

Dr. Harris, in his account of the depredations of this insect upon corn, mentions ears in which every kernel had been perforated, with many of the kernels having three or four holes in each ; but these were infested ears that had been tied up tightly in paper, and were opened after the lapse of a year, during which time successive broods had been developed and were compelled to utilize all of the available food. An ear infested to this extent, and presumably from a similar cause, is shown in Fig. 18, from Prof. Riley's Departmental Report for the year 1884.

It being important to know whether this attack was made upon the corn in the field, or after placing it in the Museum of the Experiment Station, examination was made by Mr. Ladd after learning the different conditions under which it might occur, to determine this point. He subsequently wrote: "From careful examination of the field corn, I have been unable to find a single instance of its occurrence until brought to the Museum, and I now think that the whole round of life, in this instance, is within the Museum." This conclusion is confirmed by the fact that from other ears of corn sent late in October, moths continued to emerge until into December, which would not have resulted from a field attack.

History of the Insect.

The ravages of this insect seem to have been noticed in the United States about the year 1730, when wheat was attacked by it in North Carolina. At about the same time, and probably at an earlier period, it attracted attention in France, for in 1736, the distinguished French naturalist, Réaumur, gave an account of it illustrated with figures, but did not give it a scientific name. Its ravages continued to increase until in the year 1760, they had become so extensive, that the attention of the government was drawn to it. At that time "the insect was found to swarm in all the wheat-fields and granaries of Angoumois and of the neighboring provinces, and the afflicted inhabitants were thereby deprived not only of their principal staple, wherewith they were wont to pay their annual rents, taxes, and tithes, but were threatened with famine

and pestilence from the want of wholesome bread."* Two members of the Academy of Science of Paris were appointed as Commissioners to visit the province of Angoumois, and investigate the insect. They did so, and their report was published in the Memoirs of the Academy, and also as a separate volume for more general distribution, under title of "Histoire d'un Insecte qui dévore les Grains de l'Angoumois," Paris, 1762, 12 mo.

In 1768 a communication upon it was presented to the American Philosophical Society of Philadelphia, by Colonel Landon Carter, of Virginia, entitled "Observations concerning the Fly-Weevil that destroys Wheat." (Harris.)†

In 1796, the insect was so abundant in North Carolina as to extinguish a lighted candle when a granary was entered at night.

In following years it continued to spread, extending itself into several of the States, particularly those lying within the "wheat belt." Notices of it were communicated to the agricultural papers and journals, among which are those of Mr. Edward Ruffin, of Virginia, in 1833 and 1847, of Mr. S. Judah, of Indiana, in 1845, and of Mr. Richard Owen, of Indiana, in 1846, as referred to by Dr. Harris.

Description of the Moth.

The moth, reared from corn, is 0.60 in. (average of seven examples) in expanse of wings. The head is smooth, the antennæ are nearly as long as the body, tapering moderately to the tips, each joint being tipped with black upon the upper side. The palpi are long, curving backward over the head like horns, the joints quite distinct, the last one banded with black near its tip. The body and fore-wings are a dull yellowish or buff color (coffee-and-milk) and of a satiny lustre, especially on the under side of the wings. The front wings are long and narrow, freckled with black scales, which are thicker toward the tips, and forming a line along the plait of the wings; the fringe is of a paler color, long, often traversed with a black line near their attachment to the wing. The hind wings are blackish, of a leaden lustre, narrow, very sud-

FIG. 19.— SITOTROGA CEREALELLA: *a*, the larva; *b*, the pupa; *c*, the moth; *d*, the wings of a paler variety; *e*, the egg; *f*, kernel of corn [illegible] the work of the larva; *g*, tubal portion of the moth; *h*, anal segment of the pupa — all enlarged except *f*.

*Harris: Treat. Ins. Inj. Veg., 1862, p. 500.

†Mr. E. C. Herrick, in the Report of the Commissioner of Patents for 1844, p. 75, refers to a communication upon this species from Colonel Carter, in the *Trans. Amer. Philosoph. Soc.*, vol. i, 1771; and another by J. Lorain, in Mease's *Archives of Useful Knowledge*, vol. ii, 1812.

denly contracted to a point near their tip; the fringe of the same color, surrounding the wings, and along the inner margin broader than the wing itself. Beneath, both pairs of wings are of a leaden color. The front pair of legs are blackish; the hind legs have two prominent pairs of spurs, and are fringed with long hairs. In Fig. 19, at *c*, an enlarged view of the moth is given. The excellent figure is from Prof. Riley's Report to the Department of Agriculture, for the year 1884, as is also the preceding one.

At *e*, *a* and *b*, in the figure, the egg, larva and pupa are shown. For description of these stages the writings cited of Dr. Fitch, Mr. Webster and Prof. Riley may be examined.

Food-Plants.

The most serious injuries of this insect have been to wheat, attacked both in the field and in granaries. It also occurs in barley, in oats and in corn. Mr. Glover has seen the moth flying about corn standing in the field, in November, in Georgia, depositing its eggs in the ears. According to the same writer, it feeds also upon grass-seed (*Entomolog. Index to Agricul. Reports — Anacampsis*, p. 4), although it is difficult to see how it could do so consistently with its concealed habit of feeding, and in all other cases, so far as known, at once burrowing into the grain and feeding and transforming therein.

Life-History.

Under natural conditions there are two annual broods of this insect; but within doors, in stored grain there are more, the number depending upon the temperature of the apartments.

The moths of the first brood make their appearance in May or June, according to the latitude and temperature of the season, and seek the grain upon which to lay their eggs — each moth depositing from sixty to ninety minute eggs, of a bright orange color. Upon wheat and similar grains these are usually placed in lots of twenty or more, in a line or in an oblong mass, in the longitudinal furrow upon the side of the grain. The eggs hatching in from four to seven days, the larva at once burrows into it at its most tender portion, and continues to feed upon the interior, packing its excrementa around it in the cavity made by its feeding. In about three weeks' time it is full-grown, when it measures about one-fifth of an inch in length. It then eats a hole outwardly for its escape when transformed into a moth, leaving only a thin film, circular in outline, of the surface of the kernel to be pushed off at its final exit. A thin cocoon of white silk is then spun within the cavity, in which it changes to a pupa. After a short pupation the pupal

case is rent, and the moth emerges, leaving its pupal case within the cocoon. This is usually in the month of August.

The moths of the first brood soon deposit their eggs for the second brood. The larvæ proceeding from these continue in the larval stage throughout the winter, to pupate the following spring, and to come abroad as a moth during the months of May or June.

So little has been added to the natural history of this insect since the observations of the preceding century — not to be wondered at, perhaps, in consideration of the better opportunities afforded for its study at that time by its excessive abundance, the distinguished scientists engaged in its investigation, and the government commission under which the studies were conducted — that the account of these observations as briefly given by M. Olivier cannot fail of being read with interest. We, therefore, translate a page (114-115) from the *Encyclopédie Méthodique — Histoire Naturelle — Insectes*, iv, 1789:

Réaumur has given us the history of another caterpillar which attacks grain, which produces a small *Alucita* that we have named *cerealella*, and which should not be confounded with the one of which we have been speaking [*Alucita granella*]. The caterpillar of *Alucita cerealella* introduces itself even into the substance of the grain, from which it does not emerge except in the state of the perfect insect, to spread itself into the fields, to couple, and to establish a new posterity upon the grains, even before they have hardened.

There appear, in the Memoirs of the Royal Academy of Sciences, for the year 1761, some observations made in Angoumois by Messrs. du Hamel and Tillet, on the caterpillars which caused, in 1760, very considerable damage to the grains of that province. It seems, from the observations of these distinguished academicians, that the insect often deposits its eggs on the heads of the wheat or the barley before their perfect maturity; that the eggs are of a beautiful orange-red color; that the larva introduces itself into the grain through a small opening which is found between the beard and the appendages of the sheath; that the larva grows insensibly without leaving the grain, which serves it at the same time for food and lodging; that it changes there to a chrysalis, and that it does not come forth but in the state of the perfect insect.

But these caterpillars attack not only the grain in the head, but also in the granaries, as Réaumur, du Hamel and Tillet have observed. When a caterpillar, newly hatched, seeks to pierce a grain of wheat to occupy it, it commences its operations at the lower end of the groove, where the outside is still soft, and consequently more easily penetrated; it spins a slight web which serves to cover it; it pierces the kernel and penetrates by degrees into the interior. Réaumur has observed that of the grains they attack more particularly wheat, oats and barley, but that they prefer the last, and locate there more readily when they have the choice. The kernels in which these caterpillars are inclosed appear like the others, since the outside has not been eaten, and that the opening through which the caterpillar entered is imperceptible; but if different

kernels be pressed, the distinction can easily be made of those which have been occupied for some time and those for a short time. The age also of the caterpillar within the kernel, up to a certain point, can be told. If the kernel yield throughout its length under the pressure of the finger, it contains a caterpillar which has nearly attained its growth, or the chrysalis of the caterpillar. If at only a certain part of the kernel it yields to pressure, the caterpillar has not eaten the entire substance, and it has yet to grow. Another means more sure, and shorter, and the more readily to know the kernels attacked by these insects or by the weevil, is to throw in water the wheat or barley: all the eaten kernels will float.

When the caterpillar is hatched, it is so small that a good lens is needed to distinguish it; it is not more than three lines long when ready for its metamorphosis; it is smooth and white, its head only is a little brown; it has sixteen feet, of which the eight intermediary are so small as to be hardly perceptible; the extremity appears to be bordered with brown hooks, disposed as a crown.

A kernel of wheat or barley contains just the amount of aliment for the food and growth of this caterpillar until its transformation. If one be opened containing a caterpillar ready for its change, only the shell will be found remaining; all the farinaceous substance has been eaten. But before changing into chrysalis, this caterpillar has an important work to do; it is necessary to provide an outlet which it would not be able to do when it attains the perfect state. The *Alucita*, unprovided with teeth, would never be able to pierce the outside of the kernel for its escape. The caterpillar cuts circularly a piece of the surface, so that it merely holds to the kernel by a portion of its circumference, of which the extent is hardly equal to the diameter of a hair; it does not, however, disturb this piece, so that it does not show so long as the chrysalis is contained in the kernel; it can hardly be told when the insect has emerged from it. After this operation, the caterpillar spins in the interior of the kernel a silken cocoon of a very fine tissue, and changes into the chrysalis. It should be observed that this cocoon does not occupy all the excavation in the kernel — the caterpillar setting off a small space in which it places all of its excrement which it was not able until then to separate.

Messrs. Hamel and Tillet have observed that these Alucitas are usually seen in two seasons, in the spring, as soon as the wheat commences to appear in the head, and these are from the caterpillars that have passed the winter in the grain; the others appear in the summer, in the neighborhood of the harvest; these produce the eggs for the first brood, of which we have spoken, and give birth to caterpillars which are to produce the moths of the following year; some of these may appear during the course of the summer, but the greater part of the number have exactly this order which, however, is sometimes accelerated or retarded by the different temperatures of the air. One thing worthy of remark is, that the moths which emerge in the month of May from grain in the granaries hasten to escape through the windows and to gain the fields; while those which are disclosed after the harvest show no inclination to escape. It seems that their instinct informs them that they will not find at that time, in the fields, that which would be needed for the well-being of their posterity.

Distribution.

In Europe, its greatest depredations have been in France, but it occurs also in several other portions of southern Europe, extending, at least, northward into Belgium.* Stainton, in his *Manual of British Moths and Butterflies*, records it in England — the larva in grains of barley and wheat, in March and October.

In the United States it probably occurs throughout the entire wheat region. We find special record of it in Massachusetts, Virginia, North and South Carolina, Georgia, Ohio, Indiana and Illinois. It has apparently not extended itself into Canada, for, in 1881, Mr. William Saunders, of London, Ont., stated that it had never, to his knowledge, been found within the limits of that Province.†

Remedies.

When the insect infests stored grains, fumigation in tight vessels with charcoal gas has been recommended. Probably the best agent for its destruction is heat, and we accordingly find the mention of this method by all writers who have considered the means of arresting the ravages of the pest. In France contrivances sometimes called insect mills, have been devised for heating infested grain, and stirring it at the time so that the heat could be uniformly distributed throughout the entire mass. According to Dr. Harris, exposing the grain in a kiln at a temperature of 167° Fahr. for twelve hours has sufficed to kill the insect, and even a very moderate temperature if continued for a length of time — as 104° for two days. Experiments made by Mr. F. M. Webster, of Illinois, to ascertain the amount of heat required, gave these results: "A temperature of 140° Fahr., continued for nine hours, literally cooks the larva or pupa. A temperature of 130° Fahr. for five hours is fatal, as is also 120° for four hours, while 110°, applied for six hours, was only partially effective." It was also found that the highest temperature above mentioned, and even 10° higher (150°), could be borne by wheat for eight hours without impairing its germinating properties.‡ The drying-rooms, arranged with steam pipes, used by many of the large grain dealers of our Western States, would afford every facility for the application of the desired degree of heat to infested grain.

Dr. Herpin, who made special study of this insect during the time of its greatest ravages in France, and who has published largely upon it,

Catalogue des Lépidoptères de Belgique, per Ch. Donckier de Donceel, in *Annales de la Société Entomologique de Belgique*, xxvi, 1882, pp. 5–161.

†*Canadian Entomologist*, October, 1881, xiii, p. 198.

‡*12th Report on the Insects of Illinois*, 1883, p. 152.

proposed exposing the infested material in close tanks to carbonic acid or azotic gas.*

Natural Enemies.

Mr. F. M. Webster has bred from the larvæ of this moth a hymenopterous parasite, which he has named and described as *Pteromalus geechiæ* (*12th Report Insects of Illinois*, pp. 151–2). It occurred in considerable numbers — often as many as eight or ten of its pupæ being associated with a single larva. It is probably the same parasite that Mr. R. Owen had discovered in Indiana, in 1846, preying upon these larvæ, of which "some farmers had noticed large numbers among the tailings of the winnowing machine." It was figured by Mr. Owen,† but not described or named. From the figure, Dr. Harris recognized it as belonging to the *Chalcididæ*, and thought that it might be a species of *Pteromalus* (*Insects Injurious to Vegetation*, p. 509).

Mr. Webster also discovered a mite preying upon the larvæ and destroying numbers of them. It proved to be *Heteropus ventricosus* Newport (*Linn. Soc. Trans.*, 1850), represented in Fig. 21, after Walker from Newport. The same species has been found by M. J. Lichstentein of Montpelier, France, infesting his breeding cages to such an extent as to destroy nearly all the Hymenoptera, Coleoptera and Lepidoptera that he attempted to rear. It was described by him as *Physogaster larvarum*.

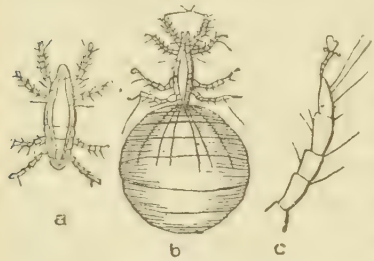

FIG. 21.— HETEROPUS VENTRICOSUS, a mite preying upon the Angoumois moth: *a*, a mature individual; *b*, female distended with eggs—both enlarged; *c*, leg greatly enlarged. (After Newport.)

For the interesting observations of Mr. Webster upon the rapid and abnormal development of this mite, and the vigorous attack made by it upon its prey, the reader is referred to Prof. Forbes' *12th Report on the Insects of Illinois*, as previously cited.

DIPTEROUS INSECTS.

Bibio albipennis Say.

The White-winged Bibio.

(Ord. DIPTERA : Fam. BIBIONIDÆ.)

SAY: in Journ. Acad. Nat. Sci. Phila., iii, 1823, p. 77; Complete Writings, ii, 1859, p. 69.

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* *Annales de l' Agriculture Francaise* for 1838.

† *Cultivator*, N. S. iii, November, 1846, p. 344.

WALSH : in Pract. Entomol., ii, 1867, pp. 45, 83 (habits).
WALSH-RILEY : in Amer. Entomol., i, 1869, p. 227 (habits).
PACKARD : Guide Stud. Ins., 1869, p. 392 (mention).
GLOVER : MS. Notes Journ.— Dipt., 1874, p. 4, pl. 2, f. 7.

The white-winged Bibio, as, in the absence of a more popular designation, it may be called, is a very common species of fly, often met with in great numbers in early spring in our gardens and orchards. Its legs and body are black — the latter elongated and soft. The wings, as the specific name implies, are white ; they are traversed by brown veins, upon one of which a blackish spot rests near the front edge. The head is small in the female, but in the male it is large, and the contiguous eyes occupy nearly all of its front, as shown in Fig. 22. The head, thorax and abdomen are clothed with a short white down. The legs of the fly, as well as the head, show marked sexual differences, which, however, have been imperfectly represented in the figures.

FIG. 22.—BIBIO ALBIPENNIS : *a*, the male fly ; *b*, the female ; *c*, front view of the head of the male ; *d*, of the female ; *f*, front leg of the male ; *e*, hind leg of the same ; *g*, hind leg of the female.

The original description by Mr. Say, of the species, and accompanying remarks are as follows ;

B. albipennis. — Black, wings white, with a fuscous stigma. Inhabits Pennsylvania.

Body with cinereous hair ; head above with black hair ; *halteres* [balancers] fuscous ; *scapus* brown ; *nervures* brown ; *tarsi* black-brown, exterior spine of the anterior tibia much larger than the interior ones.

Length, three-tenths of an inch.

This is a very common insect. The wings have a white appearance and are strongly contrasted with the color of the body, and the brown and definite stigma. The posterior tibiæ of the males are much more dilated toward the tip than those of the female.

Family Characteristics.

The family of *Bibionidæ*, to which this species belongs, is of moderate extent, as it contains only about fifty known United States species. Embracing as it does species which are neither injurious to vegetation

nor annoying to man, it is strange that the structural features that characterize it should, in classification, place it between the *Simulidæ* and the *Culicidæ* — or the "black flies" and the mosquitoes. The insects are small or of moderate size; their flight is slow and heavy. They have long legs, short antennæ, and soft bodies. Their larvæ are cylindrical, without feet, but furnished with transverse rows of short hairs, which serve them in progression in the decaying vegetable and excrementitious material in which they often occur. Their pupæ are found within smooth oval cells in the ground.

The larva of this species is undescribed,* but it probably resembles that of the "unknown species," to be referred to on a following page. Its literature is very limited, not having been noticed in the Reports of Dr. Harris, Fitch, Riley, Packard, Le Baron, Thomas or Forbes. Nearly all the references to it that we have been able to find in our entomological literature, are cited above and their purport given. A sufficient reason, perhaps, for its not having received more attention may be that it is not numbered among our injurious species. Yet the fact that it has by some writers been regarded as destructive would seem to make desirable further study of its food-habits, that its economic importance might be definitely ascertained.

Probably not an Injurious Species.

From the great abundance of these flies which have been observed at times upon apple and other blossoms, and from the common belief that nearly all insects are injurious, they have repeatedly been sent to me for name and habits, in the belief that they were a pernicious species and that their presence betokened only harm. They are, however, believed by entomologists to be entirely innocent of inflicting injury to the blossoms upon which they are often found, or to other vegetation. Under date of May 25, 1877, examples of the fly were sent to me from Utica, N.Y., where they were occurring in large numbers on potato plants. The gardener believed that they were making war upon the Colorado beetle, either by feeding on the larvæ or on the eggs; but, from what is known of their habits, there is no probability that they were engaged in so desirable a service — their association with the potato-beetle being simply from their contemporaneous appearance in the garden, and their usual sluggish habits inviting repose on any convenient foliage.

Very grave charges, it is true, have been brought against an European species, *Bibio hortulanus* Meigen. The distinguished naturalist, Ray, calls it the deadliest enemy of the flowers in spring, and accuses it of

*Glover, in *Manuscript Notes from my Journal — Diptera*, 1874, plate vii, fig. 12, gives the larva and pupa of an undetermined species of the genus, which may be *albipennis*.

despoiling the gardens and fields of every blossom. Réaumur, the noted insect anatomist, saw that, not being provided with mandibles, it was unable to gnaw the buds and petals in the manner ascribed to it, yet thought that it might cause their blight by sucking their juices. Both of these expressed views were doubtless erroneous, and its frequenting buds and blossoms is, upon the best authority, for the innocent purpose of sipping the nectar of the blossoms and the gummy secretions of the opening buds. (*Insect Transformations*, pp. 266–7.)

The larvæ are generally believed to feed almost entirely upon decaying vegetable matter. Some of them which had been found "in bunches" in an asparagus bed, in Missouri having been sent to Mr. Walsh for name and habits, after rearing the fly from them he wrote as follows of the larvæ :

They feed exclusively on dead vegetable substances in a moist and decaying state, and are not very particular as to what that substance may be. Years ago I had a parcel of them feeding on damp leaves in a glass vase, and on putting several dozen of our common "oak apples," into the vase, I was surprised to find that they, most of them, quitted the leaves and burrowed into the oak apples. I have always found them as you did — in large crowds together. They should not be destroyed, as they do no harm in either the larva or the fly state. (*Practical Entomologist*, ii, 1867, p. 83.)

The earlier statements of injuries to growing vegetation were probably from surmise only, and not based on actual observation. Thus, in connection with a plea made for the robin, upon the ground that it destroyed so many of these larvæ — from one to two hundred in a fresh condition having been taken from the stomach of a single bird — it was said : "The larvæ are very destructive, feeding on the roots of plants, and injuring strawberry plats, vines, borders, etc. They live in swarms, perforating the ground like a honey-comb, the fly depositing all its eggs in one place" (Glover, *in Rept. Commis. Agriculture* for 1864, p. 441).

Eaten by the Robin.

The food of the robin, *Merula migratoria*, during the early weeks of its appearance in the spring, consists largely of the larvæ of this fly. Of two robins examined in the month of March by Prof. S. A. Forbes, State Entomologist of Illinois, sixty-seven per cent of the contents of the stomachs consisted of this larva, and the same larva was found by Prof. Jenks, of Brown University, to constitute about nine-tenths of the food of the robins examined by him in Massachusetts in February and March, 1858 (S. A. Forbes, in *Trans. Ill. State Horticul. Soc.*, xiii, 1879, p. 128).

Abundance of the Larvæ.

The surprising number in which these larvæ at times occur may excuse the alarm which they sometimes excite.

During the latter part of the winter of 1881–82, they occurred in great abundance in several localities in the town of Morley, St. Lawrence county, N. Y., and occasioned much anxiety, as they were believed by those who first noticed them to be the same insect that had devastated the grass lands of that portion of the State the preceding spring, viz., the Vagabond Crambus, *Crambus vulgivagellus*.

It may not be a simple coincidence that the piece of land where they were the most abundant was the particular field to which in my visit to this town the year before to examine the operations of the Crambus, I had first been taken, that its greatest devastation might be shown to me. Could the unusual amount of dead and decaying grass roots left in the ground from the death, in large part, of the grass the previous year, have induced the deposit of an extraordinary number of the Bibio eggs — the instinct of the parent flies recognizing the presence of the needed food-supply for its larvæ?

After "a very long continued heavy rain on March 1, lasting about fifteen hours, and a steady pour all the time," the larvæ were found lying upon the ground under leaves, sticks and other covering, often in such numbers as to form a mass of an inch in thickness.* They had been observed, but in less abundance, for some days previous to this rain, when, according to a representation made, "several quarts of them could easily have been gathered."

Transformation to the Fly.

Over a hundred of the larvæ sent to me by Secretary Harison of the New York State Agricultural Society, on March 2, were placed upon a dead grass sod in my office, on March 6, when they at once commenced burrowing into it, and soon disappeared from sight. They were doubtless near their pupation, for three weeks thereafter (March 29), the first *Bibio albipennis* emerged — a male. On the 30th, eight males and three females were disclosed; on the 31st, four males; showing that in this species, as in a very large proportion of other insects observed, the male is the earliest to make its appearance.

Is the Species Double-Brooded?

Dr. Packard states of the species that there are two broods a year,

*See notice of large numbers of the larvæ of *Allorhina nitida*, one of the "white grubs," appearing above ground after heavy rains, in the *First Rept. on Inj. Ins. of N. Y.*, pp. 238–9.

which appear "in swarms in June and October" (*Guide to the Study of Insects*, 1869, p. 392). It has never come under my observation in the autumn, and I know of no other mention than the above, of its appearance at that time. To an inquiry made of Mr. E. L. Keen, of Philadelphia, who has been paying special attention to the Diptera, of his knowledge of a second brood, the following reply was received:

"I have been giving special attention to the *Bibionidæ*, but I never saw a specimen of *Bibio albipennis* in the fall — in fact not after July, although in May and June there are swarms of them. This last October I took a few specimens of a small black species of Bibio in a sheltered ravine."

An Unknown Species Occurring in Rose-pots.

The larvæ of a species of *Bibionidæ* were found in large numbers in rose-pots in New York city. When received, on the 13th of February, they were already nearly full-grown. They had probably been taken from a conservatory, the artificial temperature of which had hastened their growth.

They measured 0.35 of an inch in length, by about 0.05 of an inch broad. Their shape was nearly cylindrical, without feet; a rounded, corneous brown head of rather more than one-half the diameter of the body; on each of the segments, a transverse row of short papillæ, and a row of larger ones curving at the tips, on each side of the body.

Their general appearance was so unlike the ordinary dipterous forms, and so similar in the character of the head and stigmata to some of the Coleoptera that they were at first believed to be of that order.

Fig. 23.—Imago and pupa of Aspistes, sp. ? Twice the natural size.

Within a fortnight after their reception they had all entered the ground to the depth of about three inches, where they transformed to pupæ having the appearance shown in Fig. 23. The flies emerged after a pupation of about two weeks. They have a general resemblance to *Bibio albipennis*, except in darker wings, and they are only about one-half its size.

Upon submitting them to a friend who was engaged in the study of Diptera, he referred them to the genus *Aspistes*. There seems to me, however, to be reasons why they may not belong to that genus.

[Baron Osten Sacken, having seen these examples since the above was put in type, has expressed his opinion that they may be but dwarfed *Bibio albipennis*.]

Microdon globosus (Fabr.).

(Ord. DIPTERA: Fam. SYRPHIDÆ.)

Mulio globosus FABR. Syst. Antl., 1805, p. 185, No. 7.
Scutelligera ammerlandia SPIX.: Abhdl. Acad. Muench., 1824, ix, p. 1.*
Parmula cocciformis v. HEYDEN: in Isis, 1823, p. 1247; in H. Schæf. Correspondenz blatt, ii, 1861, 105.*
Microdon globosus WIEDEMANN: Aussereurop. Zweif. Ins., ii, 1830, p. 86, No. 11.
Dimeraspis podagra NEWMAN: in Ent. Mag., v, 1838, p. 373.
Aphritis globosus MACQUART: Dipt. Exot., ii, pt. ii, 1841, p. 13, pl. 1, f. 4.
Microdon globosus. PACKARD: Guide Stud. Ins., 1869, p. 398, f. 17.—GLOVER: MS. Notes Journ.-Dipt., 1874, p. 32, pl. 8, f. 20.—OSTEN SACKEN: in Bull. Buff. Soc. Nat. Sci., iii, 1877, p. 41; Cat. Dipt. N. Amer., 1878, p. 119.—MANN: in Psyche, iii, 1882, p. 379.

This species will serve to illustrate the great variety of forms that prevails in the early stages of the different genera of this extensive family. In Fig. 24 the curiously spherical larva, the puparium and the perfect insect are shown, as given in Packard's Guide. So unusual and remarkable are the larval and pupal forms of this insect, that the latter has twice been referred to a different class of the animal kingdom, and described among the Molluscs, as a land snail, viz., by Hayden in 1823, as a species of *Parmula*, and by Spix in 1824, as a *Scutelligera* (see synonymy above). One of the puparia was received by me in the month of April, from Mr. C. M. Weed, of Lansing, Mich. From having been apparently dried before placing it in alcohol, it was hardly recognizable when it came to hand, but it was identified by Dr. Hagen, to whom I am also indebted for portions of its synonymy. It had been found by Mr. Reed in an old and decaying log, with some ants. Dr. Packard states that it occurs under sticks, in company with shells.

FIG. 24.—MICRODON GLOBOSUS: *a*, the puparium, *s*, the spinal tubercles and *v*, the vent; *b*, anterior view of the puparium; *c*, the larva just before pupation (enlarged from Packard).

Associated with Ants.

From its association in old wood with ants, in the above instance, it is of interest to recall the occurrence of an European species, *Microdon apiformis*, in ants' nests, and also that some of the larvæ of the *Syrphidæ* are known to live parasitically in nests of bees.

Microdon tristis Loew, a New York species, and also extending far northward into British America, has been observed by Dr. Williston while flying about ants' nests.

* Dr. Hagen, in making corrections to the proof of synonymy, has written: "v. Heyden and Spix belong to the European species, *Microdon mutabilis* and not to *M. globosus*, but they are the first authors for the earlier stages."

Schiner states (*Fauna Austriaca*, p. 250), that he has found the larvæ of European species, resembling small slugs, in colonies of *Formica rufa*, and also under logs in cattle pastures.

Hibernation of the Fly.

Mr. B. P. Mann states of the fly, *loc. cit.*: "I remember that, during one or two years, at a certain season, which, as far as my recollection serves me, was in April, I noticed numerous specimens of *Microdon globosus*, issue from a nail-hole in the plastered wall of an apartment in a dwelling-house, as though the flies had passed the winter within the walls of the house." In this manner of hibernation within dwelling-houses, it conforms to a similar habit recently published of *Pollenia rudis* Fabr., one of the *Muscidæ*, which often occurs "in large numbers in the State of New York, in unused apartments of houses, under table-cloths, in pillow-cases and wherever similar snug places of concealment could be found." And it is not uncommon to meet with large companies of these "cluster-flies" in the angles of the ceiling and the walls of unoccupied rooms.

Distribution.

Baron Osten Sacken gives the range of this species as the Atlantic States. It was first described by Fabricius, from examples received from Florida. Dr. Williston has received it from Massachusetts, Connecticut, New York and Pennsylvania and Virginia. Michigan is now to be added to its known localities.

The genus appears to pertain to the eastern part of the North American continent, for while eight or nine eastern species have been catalogued for some time past, it has only been recently discovered upon the Pacific coast in a single species which is as yet undescribed.

Trypeta pomonella Walsh.

The Apple Maggot.

Ord. Diptera: Fam. Trypetidæ.)

Walsh: in Amer. Journ. Horticul. for Decem., 1867, pp. 338–343; 1st Ann. Rept. Ins. Ill., 1868, pp. 29–33, figs. 2, 2a.

Walsh-Riley: in Amer. Entomol., i, 1868, p. 59 (prob. ident. of insect from N. Y.).

Loew: Mon. Dipt. N. A., Pt. iii, 1873, pp. 265–268 (descr. and remarks).

Glover: MS. Notes Journ.—Diptera, 1874, p. 58, pl. 9, f. 14 (br. ref. and authority).

Comstock : in Rept. Comm. Agricul. for 1881–1882, pp. 195–198, pl. 14 (operations, larva, pupa, imago, remedies).

Saunders : Fruit Insects, 1883, pp. 135, 136, f. 143.

Cook : in Count. Gent., xlix, 1884, p. 857 (habits and occur. in Mich.); 14th Ann. Rept. Mich. St. Horticul. Soc., for 1884, 1885, pp. 200–203, figs. 1–3 (general notice).

Lintner : in Bull. N. Y. Agricul. Exper. Station, lxxv, Dec. 29, 1883 (description, habits, etc.).

In November, 1883, the following letter of inquiry was submitted to me from the Horticulturist of the New York Agricultural Experiment Station, with the request that I would make reply to it :

We are troubled here with a worm that completely destroys our apples. It seems to be different from our common apple-tree worm — not so large, but looks like the apple-tree borer when small. Last year was the first that I was troubled with them. The apples look well on the outside, but when cut they are found to be completely honey-combed by the worm, making them worthless. Last year they worked in my Spitzenberg apples. This year the Spitzenbergs are good, but the worms worked in the Northern Spy, Talman sweeting and Fameuse, and entirely spoiled them. They also worked some in other kinds. The Rhode Island greenings are free from them yet, and the Baldwins are but slightly injured. There is a general complaint this year.

The question which I wish to ask is, are these worms going to spread until it is impossible to raise apples fit to use, or is there some way to stop them? Last year I took pains to pick up all the poor apples in hopes thus to destroy them, but failed, as they have increased ten-fold from last year. But I do not understand why the Spitzenbergs were ruined last year and are so fair this year. If you can give me any light on the subject, it will be thankfully received.

M. P. JUNE.

Brandon, Vt.

My reply to this inquiry was published in the *Husbandman* [of Elmira, N. Y.] for December, 1883, and also issued, in slips, as Bulletin No. LXXV, of the New York Agricultural Experiment Station. It has been somewhat extended and re-arranged in the present notice.

It is quite probable (the infested apples were not submitted for examination) that the insect whose operations are above stated is the one popularly known as "the apple maggot," and scientifically as *Trypeta pomonella* Walsh. The species was first described and named by Mr. B. D. Walsh, in 1867, in the American Journal of Horticulture.

The Larva.

Operations. — Mr. Walsh writes of its work as follows : "It tunnels exclusively the flesh or pulp of the apple (unlike the apple-worm, which burrows chiefly in the core and the portions immediately surrounding)

making therein little rough, roundish, irregular and discolored excavations about the size of peas, which, when several of the larvæ are at work on the same fruit, often run together, so as to render the whole a mere mass of useless and disgusting corruption."

The following is Mr. Walsh's description of the larva, which is given entire, as the report in which it is contained has become quite rare, and it has never, to my knowledge, been republished. With the description and the larva in hand there should be no difficulty in determining the species whenever the burrowing of the apple, as above described, renders its presence probable :

It is of a greenish-white color, 0.15, 0.20 inch long, and about four and one-half times as long as wide, cylindrical behind, with the tail-end squarely docked, tapering on front from the middle of the body to the head ; head pointed, but narrowly excavated (emarginate) in front ; its inferior surface with two slender, bluntish, coal-black hooks projecting in front, where the mouth is protruded [mouth-parts, used in feeding, shown in Fig. 25], at the base of which there is a smaller pair connected with the base of the others like the antlers of a buck's horn ; at the base of the first segment, behind the head, a dorso-lateral, transverse, pale-brown, flattish, rough tubercle [one of the spiracles] ; last segment below with two pale-brown, horny, rough tubercles, each composed of three minute thorns longitudinally arranged ; and above, with two whitish retractile ones, each pair of tubercles transversely arranged.

Fig. 25.— Head of the larva of Trypeta pomonella, in front and side view, showing the mouth-parts and the first spiracle. (After Comstock.)

Prof. Comstock, who has made special study of this insect, has given an enlarged figure of the larva (*loc. cit.*), which we copy, somewhat reduced, in Fig. 26 at *a*, and the following descriptive features : The larva averages about one-fourth of an inch in length (0.19–0.27 in.), is footless, white with sometimes a yellowish or greenish tinge. The anterior third of the body tapers slightly to the head — the latter smaller than any of the segments. The posterior two-thirds of the body is cylindrical, having the end obliquely truncate, bearing upon its slope four pairs of tubercles — one pair more prominent than the other.

The Fly.

Trypeta pomonella, in its perfect state, is a pretty fly, shaped not unlike the common house flies that we find upon our windows. The figure given does not present the usual shape of the abdomen in the examples in my collection. In these, it is the broadest quite near the base where the first and second of the four conspicuous white bands should appear, and thence tapers conically to the pointed tip. It may be easily recog-

nized by the peculiar pattern of its wings, by the white spot behind the thorax (the scutellum), and the white bands of the abdomen. With its wings expanded, it measures across them about one-fifth of an inch. They are "whitish, glassy, banded with dusky, somewhat in the form of the letters I F — the I placed next the base of the wings, and its lower end uniting rather indistinctly with the lower end of the F; the base and the extreme tip of the wing being always glassy" (Walsh).

Fig. 26, *c*, after Comstock, represents the male fly.* The following more particular description is abridged from Dr. Loew's *Review of the North American Trypetina:* The color is brownish-black. The head is pale yellowish with a narrow dark yellow front, and yellow antennæ. The thorax shows four rather narrow longitudinal stripes of whitish pollen, arranged in pairs and confluent anteriorly. The scutellum is white, with black upon the sides and base. The first four segments of the abdomen are broadly banded behind with white pollen — the last segment is without the band. The ovipositor of the female is black, broad, truncate, about once and a half the length of the last segment. The legs are mainly clay-yellow, thus: posterior femora black with a clay-yellow tip; front femora clay-yellow with a large, broad brownish-black stripe upon the hind side; tibiæ and tarsi clay-yellowish. The wings are hyaline, with four black crossbands, the first of which lies near the base; the last three are connected near the anterior margin and divergent toward the posterior one. Length of body, 0.17 in.; with the ovipositor, 0.19 in.; length of wing, 0.17 in.

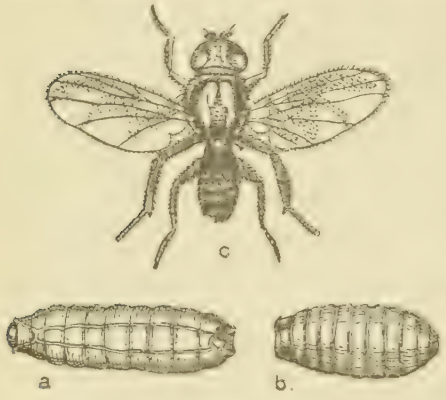


FIG. 26.—TRYPETA POMONELLA: *a*, the larva; *b*, the puparium; *c*, the fly. (After Comstock)

Life-History.

The life-history of this species is briefly this: The fly may be seen about apple trees in July. During the latter part of the month, or in August, it deposits several of its eggs upon an apple near the calyx end, where the fruit may have been already burrowed by the apple-worm of the codling-moth, *Carpocapsa pomonella*. According to Mr. Walsh, the eggs are inserted by the ovipositor of the fly within the flesh of the ap-

*The figure fails to represent correctly the one from which it was taken. From the reduced photograph furnished the printer for a wood-cut, a pen and ink sketch was made and photographed, in which proportions have been changed, veins and other features omitted, and additions made. Figs. 21 and 25 and some others need the same explanation.

ple; but this must be an error, unless they should be deposited in worm-holes previously made, for the soft, blunt ovipositor could not pierce the peel for the purpose. The presence of the larvæ, of which, sometimes, as many as a dozen occupy a single apple, is seldom noticed until in September. During the autumn they become full-grown, when they leave the fruit through small circular holes cut in the peel, and enter the ground, where, within the contracted larval skin, they assume the pupal state. In this condition they remain during the winter and until the following July — a pupation extending over about nine months.

If some recent observations upon this insect in some of the Western States are reliable, then, in some instances, the larval stage of the insect extends far into the winter. Dr. F. W. Goding, of Ancona, Mich., states that he has seen the larvæ within apples shipped from Michigan, eating the fruit in the month of January, but that they soon after entered the earth and changed to pupæ. Some that had been kept in a cooler room did not change until in March. From the earliest pupæ, flies were obtained about February 1st (*Fruit-Growers' Journal*, Cobden, Ill., April 30, 1885).

Distribution.

The fly is a native species — one of the few insect pests that has not been introduced from abroad. For a number of years before it was detected infesting the apple orchards of the Eastern States and New York, it had been observed in Illinois, feeding upon the native haws or thorn-apples (*Crataegus*) and upon crab-apples (*Pyrus* species). Until very recently no attack from it upon cultivated apples had been noticed in the Western States, but during the present year (1884) Prof. Cook has discovered it in a barrel of autumn apples procured from Shiawasse county, Mich., which were found to be entirely ruined by it. He had also learned that it was quite common in the fruit in and around Lansing, Mich. (*Count.-Gent.* for Oct. 16, 1884).*

The most frequent notices of the presence of the insect, and most serious accounts of its injuries, have been received from Vermont. In New Hampshire, in a few localities, it has ruined entire orchards (*Rept. Comm. Agricul.* for 1881, p. 190). In the vicinity of East Falmouth, Massachusetts, it has been reported as very injurious (*1st Rept. Ins. Ill.*, 1868, p. 31). Mr. L. L. Whitman has written me from his resi-

*Later, Prof. Cook reports its presence in at least six counties in Michigan, and had learned that in 1883, a year before it was noticed in Michigan, it was doing much harm in Wisconsin to cultivated fruit. These attacks were the result of new importations from the East, or the native insect had of late taken upon itself a new and refined regimen. (*14th Rept. Mich. St. Horticultural Society*, for 1884, p. 200-1.)

dence at North Ashburnham, Mass., "I had hundreds of bushels of the finest fruit rendered worthless by the apple-maggot last year" [1883]. Mr. Walsh received larvæ and pupæ from Connecticut, from which he reared the fly (*Ib.*, p. 31). In New York State it has proved a great pest at North Hempstead, Long Island. Mr. Trimble, of New Jersey, in 1867, stated that it was very plentiful throughout the Hudson River country, but had not been observed in his State. It has been prevalent at the Oneida Community, where it was mostly confined to certain varieties of autumn apples (*Rept. Comm. Agricul.* for 1881, p. 196). Prof. Comstock, of Ithaca, has observed it in one of the orchards of Cornell University, in only a few varieties, not specified (*Id., ib.*). From Franklin, Delaware county, larvæ have been reported as "living in the pulp of the apple, making long winding roads through it and appearing to come out through the skin" (*Amer. Entomol.*, i, 1868, p. 59). In Schenectady the fly has occasionally been captured by me upon fruit-trees, from the 3d to the 27th of July — at different times upon the leaves of a cherry-tree, where it had probably been drawn for the purpose of feeding upon the "honey-dew" of *Myzus cerasi*, which it incites the aphis to secrete after the manner related by Dr. Fitch in his *First Report on the Insects of New York*, p. 65, of *Tephritis melliginis*.*

Preference for Early Apples.

As the insect, during its past history, has shown a decided preference for summer and autumn apples, its attack upon Spitzenbergs, mentioned by Mr. June, is of interest, as an extension of its sphere of operations. In Massachusetts the crop of some summer sweets had, for a series of years, been completely destroyed by it. In New Hampshire, in the towns of Hancock and Dublin, where it was reported as the most destructive of all apple insects, it was "confined to early apples as soon as they ripen." From Long Island it is stated that "only in the ripest apples and in sweet and mellow subacid fruit are they found by us" (*Rept. Comm. Agric.* for 1881, p. 196).

It seems, however, by no means to be confined to the early fruit, for in Wallingford, Conn., the Baldwin and some other varieties of winter apples were infested. A gentleman writing from this place states: "Two weeks ago [the letter was written shortly after November 12th] we overhauled two hundred and fifty bushels of apples that we had gathered and placed in store for winter use, and of that number we threw out fifty bushels, most of which had been rendered worthless, *except for cider* [!!!] or hogs, by the apple-worm or apple-maggot. The apple-worm [*Carpo-*

* Is *Rivellia viridulans* R. Desv. (O.-S. *Cat. Diptera N. A.*, 1878, p. 182.)

carpsa pomonella] by this time has ceased its work, but the depredations of the apple-maggot continue up to the present time, converting the pulp of the apple into a mere honey-comb and rendering another overhauling, soon, indispensable."

As a possible explanation of the statement of Mr. June that Spitzenberg apples were free from attack in 1883, when they had been destroyed the preceding year, the following is offered: The period of time during which apples are liable to attack in the deposit of the eggs may be comparatively brief. At the time when the fly was abroad, in 1883, and engaged in oviposition, the Spitzenbergs, from seasonable peculiarity, may either have been not far enough, or too far, advanced for the reception of the eggs.

Remedial Measures.

In the event of its being found by examination that the infested fruit, to any large amount, falls to the ground with the contained larvæ, it is obvious that much may be done by giving sheep the range of the orchard to feed upon the apples, or, if this be not practicable, then to pick them up and feed them to stock. But, from the statement of Mr. June, it seems probable that the fruit which fell from the trees did not contain larvæ. This would seem to be supported by the fact that I can recall, a few years ago, seeing a variety of early apple (the kind not noted) offered for sale in the Albany market, which, while entirely fair externally, and showing none of the bruises of windfalls, upon being cut into, the central portion was found burrowed after the manner described and semi-pulpy, and still retaining the larvæ — with little doubt, those of this *Trypeta*.

Additional observations are needed upon the time and manner of the larvæ leaving the fruit, and, in the earlier kinds of apples, entering the ground, while in the later and stored varieties it is desirable to learn where the insect goes for pupation. Until these facts are ascertained, with others that are needed to complete the life-history, we will not be able to do much toward mitigating the evil. The attack of the apple-worm producing the codling-moth may be to a great extent prevented by showering the trees soon after the setting of the fruit with Paris green or London purple in water, but the month of July, when the Trypeta deposits her eggs, would be too late for the application of these poisonous substances to the early fruit. At the present our efforts may, perhaps, be directed with the best success toward the destruction of the insect in its pupal state. If it shall be found that the pupation, as a rule, takes place in the orchards, beneath the infested trees, in the ground at the depth of an inch or two, then it may easily be reached there. But, if the pupation follows the storing of the fruit, then the discovery of the retreat of the larvæ for pupation should give us the means for their destruction.

Desiderata in its Life-History.

The injuries from this insect have already been serious in some localities, and their extension is threatened over the Western States where the species exists but has not yet learned to prey to any very serious extent upon cultivated apples. As it may be regarded at present as a local pest, it should be carefully studied by those who have the opportunity of observing it. As a guide to such study, attention is called to the following points, which specially need to be determined:

Are the eggs of the fly distributed over the apple or placed only near the calyx end?

Do the larvæ occur in apples which have not been perforated by the apple-worm of the codling-moth or some other insect?

How long a time is required for the larvæ to attain their growth?

How do the larvæ leave the fruit — by several holes through the skin, through a single hole, or only when the apple has become broken down from decay?

When entering the ground for pupation, to what depth do they bury? This could be ascertained by providing them with a box containing a few inches of earth for their burial.

Are both the early and late fruits similarly attacked by this insect? It is possible that the larvæ reported in winter apples may be of a different species.

During what months and portions of months are the larvæ to be found in the apples?

Are the puparia (see *b*, in fig. 26), to be found at the bottom of apple barrels, or bins in cellars, or between the staves or boards? Should any doubt exist of the identity of the puparia found under such conditions, the fly should be reared from them to determine the point.

Other Species of Similar Habits.

The qualified naming, at the commencement of the notice of the insect of which inquiry was made, was necessary, in the absence of examples for examination, there being two other species of flies which attack and injure apples in much the same manner as the apple-maggot.

The first of these is believed to be a species of *Drosophila*. Its operations in early apples were described in Vol. II of the *American Naturalist* (p. 641). The fly and the puparium are represented in Fig. 27. The larvæ enter the apple either through the calyx end, the hole bored by the Carpocapsa apple-worm, or the cut of the Curculio. They mature in August and September, and are followed by

FIG. 27.—An apple-fly, DROSOPHILA, of an undetermined species: *a*, the larva.

another generation. The puparia are to be found in the bottom of apple barrels in cellars, and the flies appear in the spring. The species does not appear to be known to entomologists, and it has therefore been given in the recently published volume of Mr. Saunders on *Insects Injurious to Fruits* as *Drosophila* ——— ? In Packard's *Guide to the Study of Insects*, it is referred to (p. 414) as the Apple-Fly. It was also noticed in my *First Report on the Insects of New York* (p. 219), together with the larvæ believed to produce the fly.

The other species is the *Molobrus mali* as named and described by Dr. Fitch in his *Second Report on the Insects of New York* (Reports I and II, 1856, pp. 252–254), but now known as *Sciari mali*. It belongs to the *Mycetophilidæ* which has place next, and is closely allied to, the *Cecidomyidæ* containing the wheat and clover midges and the Hessian Fly. This species has been given the name of the apple midge. Its larvæ and pupæ need not be mistaken for either of the two preceding species, the larva being long, slender, shining, glossy-white, without feet or tubercles (family features, the specific ones, it is believed, have not been recorded); while the pupa is not hidden within an outer case, but shows distinctly the legs, wings and other external features of the future fly, and, moreover, remains within the fruit — the fly emerging from it and escaping through the opening previously made by the codling-moth caterpillar.

INJURIOUS COLEOPTEROUS INSECTS.

Amphicerus bicaudatus (Say).

The Apple-twig Borer.

(Ord. Coleoptera: Fam. Ptinidæ.)

Apate bicaudatus Say: in Journ. Acad. Nat. Sci. Phila., iii, pt. ii, 1824, p. 319.

Apate bicaudatus. Harris: Rept. to Amer. Pomolog. Soc., 1854, p. 7 (brief notice of distrib., etc.).

Bostrichus bicaudatus. Fitch: in Trans. N. Y. St. Agricul. Soc., for 1856, xvi, p. 330; 3d Report. Ins. N. Y., 1859, p. 12, No. 12 (brief notice).

Bostrichus bicaudatus. Uhler: in Rept. Commis. Pat. for 1860, p. 321, 1861 (descr. and remedies).

Bostrichus bicaudatus. Walsh: in Practical Entomol., i, 1865, p. 27, f. 3 (habits and distribution).

Bostrichus bicaudatus. Walsh-Riley: in Amer. Entomol., i, 1868, p. 80, f. 69; p. 206, f. 141.

Amphicerus bicaudatus. SHIMER: in Trans. Amer. Ent. Soc., ii, 1869, pp. viii, ix (in grape vines).

Amphicerus (Bostrichus) bicaudatus. GLOVER: in Rept. Commis. Agr. for 1872, p. 118, fig. 8.

Bostrichus (Amphicerus) bicaudatus. RILEY: 4th Rept. Ins. Mo., 1872, pp. 51–53, figs. 24, 25 (appear., habits, etc.); 5th Rept. do., 1873, p. 54 (occur. in N. J. and Md., and larval food-plant).

Bostrichus (Amphicerus) bicaudatus. THOMAS: 6th Rept. Ins. Ill. [1877], p. 123 (descr. of beetle).

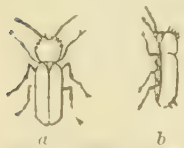
Bostrichus bicaudatus. OSBORN: in Trans. Iowa St. Horticul. Soc. for 1879, p. 94, 1880 (brief notice).

Amphicerus bicaudatus. RILEY: in Amer. Entomol., iii, 1880, p. 51, figs. 11, 12.

Amphicerus bicaudatus. SAUNDERS: Ins. Inj. Fruit, 1883, pp. 33–35, figs. 21, 22 (general notice).

This little, and sometimes quite destructive beetle, has long been known in our Western States, especially in Michigan and Illinois, from its more frequent occurrence there, but has not, until recently, been found in the State of New York. It extends southward, at least, into North Carolina, and in the south-west into Texas.

It is a small, cylindrical, dark chestnut brown beetle, black beneath from one-fourth to three-tenths of an inch long, with a small depressed head, its thorax quite elevated and spinose, and extended in front in two little horns. The wing-covers are also rough, granulated, and in the male they terminate in two short horns, as shown at *b* in the accompanying outline figures, from which feature it derived its specific name, meaning *two-tailed.*



a *b*

FIG. 25.—The Apple-twig borer, AMPHICERUS BICAUDATUS; *a*, the female; *b*, the male.

The original description by Mr. Say is quite brief, as follows:

A. bicaudatus. Dark reddish-brown; thorax asperous and bicornate before; a prominent obtuse spine near the tip of the elytra.

Vegetation Attacked.

The insect, as appears from its common name above given, usually attacks the twigs of apple-trees. It is, however, known to occur upon the pear and cherry-tree under like conditions, and has also been found within grapevines, doing far more harm to them than to fruit-trees, if the statement made to the Department of Agriculture and quoted by Mr. Glover (*loc. cit. sup.*), can be relied upon, viz.: "In Iowa, seven to nine-year-old vines are killed from the root up by these insects, and out of fourteen vines eleven were killed" (they were identified by Mr. Glover as *A. bicaudatus* from examples within the vines).

The statement was also made to the Department, that the same beetle had done much damage in Kansas by boring into twigs of young hickory.

Habits of the Insect.

The habits of this little borer are peculiarly interesting, from the fact that it is the mature insect that inflicts the injury by boring the twigs, instead of the grub or larva, which is the usual depredator. Its method of attack is as follows: Just above a bud, at a point from six to twelve inches from the tip of the twig, it gnaws a hole of about one-twelfth of an inch in diameter (the size of its body), and burrowing therein passes downward into the heart of the twig for the distance of an inch or an inch and a half, or occasionally upward, as represented in Fig. 29. This is done soon after the beetle emerges from the pupa state during the months of May or June, for the purpose of feeding and for shelter, and not, as would naturally be supposed, to provide a suitable place for the deposit of its eggs. Both of the sexes, it is said, are found within these burrows, and always with the head turned from the opening — a reverse position from that which would follow their pupation within the twig and provision for their subsequent escape through the opening.

FIG. 29.— BURROW of AMPHICERUS BICAUDATUS in apple-twigs.

Life-History.

Of the early stages but little is known. Judging from the range of food-plants which the beetle allows itself, it is probable that the larvæ will prove to have a corresponding range. Thus far it is known only to breed in grapevines, from which it has been reared by Dr. Shimer. Larvæ sent by him to Dr. Packard, which had been taken from grape, were "much the same form as *Lyctus*, but the head is more prominent and also the sides of the body. The anterior half of the body is considerably thicker than behind, and the legs are provided with long hairs; the end of the body is smooth and much rounded. It is 0.30 of an inch long."*

*Is there still room for questioning a grapevine food-plant for this larva? In 1872, Prof. Riley wrote in reference to it: "The probabilities are that Dr. Packard's description [above quoted] was in reality from this last-named species" [*Sinoxylon basilare*] (*4th Mo. Report*, p. 52). In 1873, Dr. Shimer having communicated the fact that he had found a note attached to an example of *A. bicaudatus*, of its having been bred from grapevine, Prof. Riley concedes that it "substantiates the statement in Packard's *Guide*, giving at least one known food-plant for the larva, and proving the great similarity between it and that of *Sinoxylon basilare* Say" (*5th Mo. Report*, p. 51). In 1880, we have this statement under a notice of *A. bicaudatus*: "The breeding habits of the insect are not yet known with certainty, for while Dr. Henry Shimer found certain larvæ in grapevines which he conjectured to be of this species, yet they were doubtless those of an allied beetle *Sinoxylon basilare* Say.— C. V. R. in *New York Tribune*" (*American Entomologist*, iii, 1880, p. 51).

In addition to our ignorance of the early stages of this insect — of the eggs — of the larval duration — of the pupation, but little is apparently known of its final perfect stage. And the knowledge that we have of it does not appear to sustain the following inferences :

"We may infer that it comes to maturity late in the summer, and flying into our orchards and vineyards, the beetles bore into twigs during the fall. Here winter overtakes them, and they hibernate in the holes, some of them dying; but most of them surviving until spring, when they continue feeding for a while, and afterward repair to the forest again to propagate their kind" (*loc. cit. sup.*).

This insect is of rare occurrence in the State of New York, and in this region of the United States, and it has, therefore, not been my privilege to study its habits. It appears not to have been carefully studied, for its literature is quite limited, but in all the observations upon it that I have been able to find, I can see nothing to warrant the hypothetical life-history above given. I find no observation of the beetle entering twigs in the autumn, nor any direct testimony of actual *hibernation* in apple-tree or pear-tree twigs. That the beetles have been found within them in the winter is mentioned by different writers, but the only direct statement of personal observation of the fact, published, is that of Mr. Walsh, quoted below, in connection with statements of others bearing upon the burrowing habits. Of the fact that they are to be so found, there can be no doubt, as I have before me a letter received from Prof. Riley, in reply to an inquiry made while writing this notice, in which he asserts : "There is no doubt about *Amphicerus bicaudatus* hibernating within the bored twigs and various trees. I have often received the beetles in the twigs at different times during the winter and spring."

With no desire to be hypercritical, but only to educe the truth, it must be said that neither the above statement from its distinguished source, nor any other known to me, *show* actual hibernation. No mention is made of the condition of the beetle when observed. Although seen alive in midwinter, examination, longer delayed, might have shown that they failed to hibernate. If still alive in early spring — a few dying survivors among many dead companions, as were the examples found by Dr. Shimer in the month of April (see below) — the condition certainly would not be what we understand by "hibernation," nor would a hibernation terminating in death be of the slightest economic importance.

The earliest notice that I find of the boring habits of the beetle is that given by Dr. Harris, in 1854 (*loc. cit.*) He states : "Prof. S. P. Lathrop, of Wisconsin University, and Mr. T. E. Wetmore have sent specimens to me, with accounts of the depredations of the insects,

which *are found burrowing in the pith of the branches of the apple-tree, during the spring.*"

Dr. Fitch, in 1856, represents "the twigs withering and *their leaves turning brown in midsummer*," as the result of the borings.

Mr. B. D. Walsh, in 1865, states that the beetle may be found in its burrows in the month of June, also, "I have captured the perfect insects in the woods in September; and as I once found a single specimen, in the usual situation in an apple-twig, so early in the spring that it must have been there all winter, I infer that they often pass the winter in a perfect state. The great bulk of them, however, bore the apple-twigs in June, and not in the preceding autumn; and *I have taken several in June when they were only just commencing their holes*, so that half their bodies stuck out in the open air."

The statement in the *American Entomologist*, of December, 1868, p. 80, of Messrs. Walsh and Riley, that "we have found the beetles in them [the burrows] head downwards, in the middle of winter," may, perhaps, be based only upon the above observation of Mr. Walsh.

Dr. Shimer, on April 25, 1868, found many specimens of the beetle, of which the larger proportion were dead, in galleries of dead wood of grapevines. They had doubtless been dead for some time, for he writes of them: "the dead specimens were passably fit for preserving." Upon a subsequent occasion [time not stated] he found two of the beetles boring into grapevines that had been winter-killed.

Prof. Riley, in his *4th Report on the Insects of Missouri*, in 1872, states as follows: "Both the male and female beetles bore these holes, and may always be found in them, head downwards [? turned from the entrance], during the winter and spring months."

Mr. Glover, in the *Report of the Commissioner of Agriculture* for 1872, p. 118, repeats the above statement, but obviously quoting from others.

Dr. Thomas (in 1877) presents reasons for believing that they breed in hickory.

Prof. Osborn, in 1879 (*loc. cit.*) assumes, apparently, that the beetles are in the twigs during the winter, and that the burrows are made for winter protection.

In the *American Entomologist*, for February, 1880, Prof. Riley repeats the winter occupancy of the burrows by the beetles.

Carefully weighing the above, would not a proper conclusion be, that the beetles, as a rule, and perhaps without exception, enter the apple-twigs in or about the early part of the month of June? They have been seen doing so at that time, and at no other. Otherwise this diffi-

culty presents itself: The insects "maturing late in summer" (August–September), come forth from their breeding places, are seen abroad "in September," "bore into twigs during the fall" (October–November), "hibernate in the holes" (December–March), "continue feeding for awhile in the spring," thus causing the withering of the leaves (April–June), emerge from their shelter, mate," and repair to the forest again to propagate" (in July). Where, under a calendar thus arranged, would time be found for the three earlier stages of the egg, larva and pupa?

The insufficient and unreliable data that we possess for the completion of the life-history of this insect have been dwelt upon at some length, in the hope that it will be taken up and completed by some of our entomologists or orchardists in the Western States, where the insect is of common occurrence.

We would expect, as the result of careful investigations, to find the insect as a larva within the burrows made by it in grape canes, oak, hickory, or in whatever food-plant it may hereafter be discovered, at any time during the winter and through March and April, perhaps associated in the grapevine with its fellow Ptinids *Sinoxylon basilare* and *Lyctus opaculus* (Figs. 30, 31): that passing into its pupal stage from about the middle of May to first of June, the beetle would emerge early in June; that it would at once find its mate and the female deposit her eggs, in accordance with the law known to control so many of our Coleoptera and other insects — to provide, *first,* for the continuance of the species: that this accomplished, the beetles early in June bore into twigs of apple, pear, etc., as before stated, for food: that their lives within these burrows may be and usually are prolonged for several months, at times, even through the winter and into early spring — one of the beetles having been kept alive for five months under unnatural and, therefore, presumably unfavorable conditions — within a small vial with some grapevine for food (Riley): that they do not emerge from these burrows, but complete their existence therein — most of them dying in the winter, but some lingering for a few weeks longer.

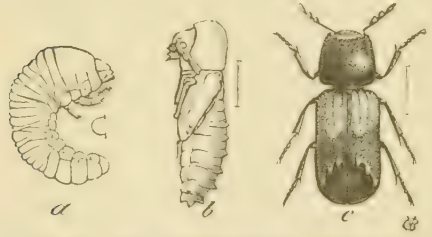


FIG. 30. — The Red-shouldered Sinoxylon, SINOXYLON BASILARE; *a*, the larva; *b*, the pupa; *c*, the imago.

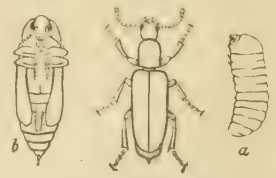


FIG. 31. — LYCTUS OPACULUS: *a*, the larva; *b*, the pupa; *c*, the imago — all enlarged (from Packard).

Such a life-history would seem to meet all the conditions under which the insect has been reported.

Injuries from the Insect.

The injuries reported from this insect have not shown it to be a very dangerous pest. Dr. Fitch simply states of it that it occasions the withering of particular twigs, and their leaves to turn brown through consuming the heart of the twig a few inches in length. — It burrows in the pith of the young branches of the apple-tree during the spring; the branches above the seat of the attack soon die (Harris). — The only damage it occasions is that the bored twig generally breaks off at the bored part with the first high wind (Walsh). — The bored twigs most always break off by the wind, or else the hole catches the water in spring and causes an unsound place in the tree. If the twig does not break off, it withers and the leaves turn brown (Riley).

The amount of harm above stated would not be serious in orchards where the moderate pruning of the last growth could be borne, but in nurseries it would be of much more account; and, in the event of the abundance of the insect, might cause the death of the trees.

The injuries to grapevines, noticed in a preceding page, were more severe, but it is by no means certain that other species were not associated with the *Amphicerus* in that instance, and were instrumental in the death of the vines.

Remedies and Preventive.

Until the early stages of the insect are known, no serviceable remedies can be suggested. It may be both practicable and desirable to employ them against the larvæ when their food-plants shall be discovered. But when the beetle stage is reached, and its operations apparent in the withered twig, if, as we believe, its eggs have already been deposited, no further harm can result from it, and it would be but a waste of time to collect the tunneled twigs for burning, as hitherto recommended.

In a nursery where a strong attack is expected, it would be well to make the effort to prevent the attack. If, at about the time when the beetles make their appearance, the young trees are showered with Paris green in water, the beetle, in attempting to enter the twigs, would probably be poisoned in eating through the bark.

A Beetle of Similar Habits.

In the *American Naturalist* for September, 1872 (page 747), we find the following notice:

We lately received from Mr. Matthew Cooke, of Sacramento, Cal., some pear-twigs in which the above-named beetle [*Polycaon confertus* Leconte] was boring in exactly the same manner as our common apple-

twig borer, *Amphicerus bicaudatus*. Mr. Cooke says that the *Polycaon* is quite injurious to apple and pear trees, and also to the grapevine. Thus, from what we know of its natural history, we may safely infer that its habits do not differ essentially from those of *A. bicaudatus*, *i. e.*, the beetle bores for feeding purposes in living twigs of fruit-trees and grapevines, never, however, ovipositing in such twigs, and both male and female being concerned in this destructive work. Both species live, in all probability, as larvæ in the dead and dry wood of forest-trees [C. V. Riley.]

In consideration of the above species, *Polycaon confertus*, being so nearly allied in classification with *Amphicerus*, it is interesting to find this close conformity in habits. They are members of the same subfamily of the *Ptinidæ*, viz., *Bostrichinæ*. While the latter, in the recent arrangement of Drs. Leconte and Horn, pertains to Tribe ii (*Bostrichinæ*), *Polycaon* has place in Tribe iii (*Psoini*), while *Lyctus*, associated with *Amphicerus* in grapevines, follows immediately after in the subfamily of *Lyctinæ*.

It is always gratifying to the economic entomologist to discover identical habits among the different members of a family, as above mentioned, as it gives the promise and almost the assurance that measures which may be found effectual in controlling one of the species will be equally serviceable against the others.

Lema trilineata (Olivier).

The Three-lined Leaf-beetle.

(Ord. Coleoptera: Fam. Chrysomelidæ.)

Crioceris trilineata Oliv.: Encyc. Method., vi, 1790, p. 203, No. 29; Entomologie, vi, p. 739.

Crioceris trilineata. Fabr.: Mant. Ins., i, 1781, p. 90, No. 49.

Crioceris trilineata. Harris: Ins. Mass., 1841, pp. 95–96; Ins. N. Engl., 1852, pp. 104–105; Ins. Inj. Veg., 1862, pp. 118–119, f. 53.

Crioceris trivittata Say: in Journ. Acad. Nat. Sci. Phila., iii, 1856, p. 429.

Lema trivirgata Leconte: Smithson. Contrib. Knowl., xi, 1859, p. 22.

Crioceris (*Lema*) *trilineata*. Fitch: in 10th Rept. Trans. N. Y. St. Agricul. Soc., xxiv, 1864, pp. 441–447.

Lema trilineata. Riley: in Amer. Entomol., i, 1868, p. 26, figs. 16, 17; 1st Rept. Ins. Mo., 1869, pp. 99–100 (from Amer. Ent.).

Lema trilineata. Packard: Guide Stud. Ins., 1869, p. 503, f. 494.

Lema trilineata. Reed: in [2d] Rept. Ent. Soc. Ont., 1872, pp. 66–67, figs. 65, 67

Lema trilineata. Crotch: Ch. List. Coleop. Amer., 1873, p. 94, No. 5554.

This insect was received from Clyde, N. Y., in the month of July, as quite destructive in potato fields. They were apparently increasing very rapidly from the many clusters of the egg (twenty or more in the cluster, laid upon the leaves.

This species has long been numbered among the many insects injurious to the potato, and is one of those that feed upon it in both its larval and perfect stages. It sometimes occurs in sufficient numbers to be very destructive in New York and the eastern States, while proving comparatively harmless elsewhere. In portions of New York, it has been reported as destroying the potato vines for successive years (*Practical Entomologist*, i, 1866, p. 113). It was quite abundant in the central counties of the State in the year 1864, and, from being regarded as a new enemy, much alarm was excited, from apprehension of its continued increase (Fitch, 10*th Report*, p. 441). In several localities in the Provinces of Ontario and Quebec it is reported as having inflicted an unusual amount of damage among field potatoes (*Report Entomolog. Soc. Ontario for* 1871, p. 67).

The Larva.

The larva has the peculiarity of covering its body with its excrements, its vent being conveniently located for that purpose upon the upper side of its terminal joint, as shown at *b* in Fig. 32. As the material is discharged, it rests upon the surface, while successive discharges force it forward toward the head until the entire back is covered with it, as in the side view of the full-grown larva at *a*, in the figure. The covering probably serves the purpose of hiding it from its enemies, and perhaps of making it distasteful to birds which would otherwise prey upon it.

FIG. 32.—The Three-lined Leaf-beetle, LEMA TRILINEATA: *a*, the larva; *b*, its terminal joints; *c*, the pupa; *d*, the eggs.

In addition to the figure of the larva given, but a few words need be added in description. It is a soft slug-like creature of the general character of the well-known larva of the Colorado potato-beetle. It is transversely wrinkled, with a line of rounded tubercles upon the sides, low down. Its color is dull yellow when young, changing to brighter yellow as it matures. The head is of about the size of the first segment of the body, flattened, smooth and black. The adjoining segment is also black. The body is oval, becoming quite thick behind its middle, and very convex on the back. The three pairs of legs on the first three joints are shining black. Behind these upon other joints are

retractile tubercles which, serving as prolegs, aid in locomotion. When full grown the larva measures three-tenths of an inch in length and about one-half as broad.

The Beetle.

The beetle is represented, in enlargement in Fig. 33. It is about one-fourth of an inch long by one-eighth of an inch broad. Its sides are parallel, with its upper and lower surfaces convex. The antennæ are brownish-black, eleven-jointed, and about half as long as the body. The head is nearly as wide as the thorax and pale yellow; the eyes black and projecting, having behind them a transverse groove. The thorax is as wide as long, constricted in the middle, and marked with two black dots, one on each side of the middle, which are sometimes quite conspicuous.* The wing-covers are yellow with three parallel black stripes, viz.: one at the meeting of the covers, which narrows toward their tip and hardly reaches it, and a broader one almost upon the outer border of each cover. Intermediate to the stripes are several lines of delicate punctures. The legs, which are short, are yellowish-red, and the four-jointed feet are black.

FIG. 33.—The Three-lined Leaf-beetle, LEMA TRILINEATA.

Life-History.

The life-history, summarized from the careful and detailed account given by Dr. Fitch, is the following:

The insect hibernates in its beetle state, and probably resorts to forests for shelter.† Coming abroad in May, they feed sparingly upon such vegetation as may be agreeable to them, until about the middle of June when the potato leaves are sufficiently advanced to furnish them with food, and place for the deposit of their eggs. The yellow, oval eggs are laid in clusters of ten or more, usually upon the underside of the leaves. They hatch in about a fortnight. The young larvæ feed in company side by side, either at the tip or on one of the margins of the leaf, but as they approach maturity, they distribute themselves over the leaves. Having attained their growth, they descend from the plants and enter the ground for pupation, where the larva constructs a cell, which it lines with a frothy secretion proceeding from its mouth, in such a quantity as to entitle it to the name of a cocoon.

*A variety occurs in which there is an additional black spot intermediate to the two ordinary ones, named var. *tripuncta*, by Fitch. The original description of Fabricius, from material credited to the Cape of Good Hope, and of Olivier, give three thoracic spots.

†Prof. Riley, in his 1st Missouri Report (as cited), represents the insect as hibernating in the pupa state—"staying in the ground all winter, and only emerging at the beginning of the following June." But Dr. Fitch had found the beetle in a torpid state, on the surface of the ground under boards on the 20th of April.

According to Dr. Harris, the eggs require about two weeks for hatching, and the insect passes about the same length of time in its larval and pupal states, but it does not appear that these periods had been accurately observed.

Dr. Fitch has expressed his belief that there are more than the two annual broods ascribed to it by most writers, viz.: the beetles appearing early in June, and again toward the end of July and early in August. He had noticed their presence in potato fields throughout the season, together with the larvæ in various stages of growth, from which it was "evident that they are not periodical, but are continually coming forth, one after another, and depositing their eggs from the commencement of their operations in June until the chilly nights of autumn suspend their work." This would conform to the continued reproduction of the successive broods of the asparagus beetle, *Crioceris asparagi*, to which *L. trilineata* is closely allied — the twelve United States species of *Lema* of the Crotch Check list uniting with the two of *Crioceris* to form the Chrysomelid tribe of *Criocerini*.

The Insect Sometimes Carnivorous.

From seemingly good authority it appears that this beetle is not an unmitigated pest, but that it renders some compensation for its occasional destructiveness, in preying upon one of its associates and kindred a far greater pest. In *Field and Forest* for July, 1877, we find the following:

The three-striped potato-beetle, *Lema trilineata*, has been doing good service this season in the west by destroying the eggs of the Doryphora, or Colorado potato-beetle. Several correspondents in Medina county, Ohio, send specimens of the insect, and report that although the potato-beetles are as plenty as ever, the larvæ are unusually scarce, which is attributed to "the new friend of the farmer." A few were seen last year, but the present season they are very numerous.

As the Lema has always fed upon the foliage of the potato, it is hoped that it will continue and extend its carnivorous habits.

Remedies.

When the insect is not very abundant, but in sufficient force to impair the foliage of the plants, it may be kept within harmless limits by occasional hand-picking, or brushing into pans of water and kerosene oil. This would be more effectual in the larval stage, as the beetle is easily alarmed and readily takes wing and withdraws itself from threatened danger.

Should the insect become very abundant, it may be destroyed by the methods used for the control of the Colorado potato-beetle, viz.: The application of Paris green or London purple.

As most of the many enemies which have acquired the habit of preying upon the Colorado beetle during the several years of its excessive prevalence will, in all probability, as readily feed upon the three-lined leaf-beetle, we need not apprehend, for some time to come, serious ravages from it in our potato fields.

Tribolium ferrugineum (Fabr.).

(Ord. COLEOPTERA: Fam. TENEBRIONIDÆ.)

FABR.: Spec. Ins., 1781, i, p. 324.—STURM: Faun. Deuts., 1807, ii, p. 228, pl. 47, f. d D.—WESTWOOD: Introduc. Class. Ins., 1839, i, p. 319, f. 39, 2.—HORN: Trans. Amer. Philos. Soc., 1871, xiv, p. 365.—MULLER: in Trans. Ent. Soc. Lond., 1873, p. x, Proc. (same in Canad. Ent., 1873, v, p. 156).—BANDI: Deuts. E. Z., 1876, p. 230.—HAGEN: in Proc. Bost. Soc. Nat. Hist., 1878, xx, p. 59.—SCHIÖDTE: Nat. Tidss., 1879, ii, pp. 487, 563, 587, pl. 10, figs. 18–22.—OLLIFF: Ent., 1881, xiv, p. 216.—LUCAS: Ann. Ent. Soc. Fr., 1883, ser. iii, vi, p. lxxi, Bull.

Synonyms.*

navalis FABR.: Syst. Ent., 1775, p. 56.

cinnamoneum HERBST: Kaf., 1792, iv, p. 170, pl. 42, f. 8 h H.

testaceum FABR.: Ent. Syst. Suppl., 1794, p. 179.

castaneum HERBST: Kafer, 1797, vii, p. 282, pl. 11, f. 3 E.—SCH. Syn. Ins., 1806, i, p. 153.—MCLEAY: Ann. Jav., 1825, p. 47.—LUCAS: in Ann. Ent. Soc. Fr., 1854, ser. iii, vol. ii, p. 51; *ibid.*, 1855, ser. iii, vol. iii, p. 249, pl. 13, f. 3.

ferruginea SAY: Bost. Journ. Nat. Hist., 1835, i, p. 188; Compl. Works, Ed. Lec., 1869, ii, p. 659.—DEJEAN: Cat., 1836, ed. 3, p. 221.

ochracea KNOCH: Dejean Cat., 1836, p. 221.

rubens LAP.: Hist. Nat., ii, p. 220.—Dejean's Cat., 1836, ed. 3, p. 221.

Messrs. Durant & Co., grain dealers, of 475 Broadway, Albany, sent for examination, October 25, a package of "middlings" (coarse wheat flour), which had been returned to them as being infested with insects. The material had been received by them about three weeks previous, from a firm in Chicago.

The Insect Swarming in Flour.

Examination of the flour showed it to be literally swarming with *Tribolium ferrugineum* (Fabr.), shown at *a* in Fig. 34. So abundant

* The references and synonymy have been kindly furnished by Mr. Samuel Henshaw, of the Boston Society of Natural History.

were they that the amount of the flour that could be lifted upon the point of the large blade of a pocket-knife would contain one or more of the beetles. With the lid of a tin box, an inch and a half in diameter, drawn upward three or four times for four or five inches upon the sides of the bag holding the flour, about five hundred of the beetles were taken. A closer examination of the flour disclosed a few pupæ and a large number of the larvæ. The latter, represented at *b* in the figure, were perhaps one-tenth as numerous as the perfect insect, and were of greatly varying sizes, from apparently full-grown to those about one-twentieth as large. They were quite rapid in their movements, and could hardly be taken from the flour, from the facility they displayed in burying themselves and eluding capture. The beetles were far more active in the evening by gas-light, when they would come to the surface of the flour in the glass vessel in which they were confined, where for some reason, a marked tendency was shown to collect in clusters, clambering over the backs of one another for the purpose. During the several days that they were under my observation, not a single individual was seen to take wing for flight, or to climb up the outwardly sloping side of the glass vessel.

FIG. 31.—TRIBOLIUM FERRUGINEUM: *a*, beetle; *b*, larva; *c*, larval prolegs—all enlarged. (After Westwood.)

Heat Recommended for Killing it.

Answer was returned the Messrs. Durant, of the name of the insect, its general distribution over the world through commerce, its known habits in Europe as a grain and flour-pest, the limited knowledge of it in this country, and recommending an exposure to heat as the best known method of destroying it when infesting grain in bulk or in flour. A moderate degree of heat — from 120° to 130° Fahr., continued for a few hours, would in all probability suffice to kill all of the eggs, the larvæ and the pupæ in the material submitted, while a higher temperature — perhaps 150° or more — would be needed for the beetles.

A Well-known Grain Pest in Europe.

This species has long been known to infest meal, grain and various vegetable stores in Europe, and it is somewhat singular that it has not been brought to popular notice as a pest in this country. I am not aware that any of our entomologists have written of its depredations upon grain products.

Observed as a Museum Pest.

Dr. Hagen has written of injury done by it to the collection of insects of the Museum of Comparative Zoölogy at Cambridge.* After

*Museum Pests observed in the Entomological Collection at Cambridge.—*Proc. Bost. Soc. Nat. Hist.*, Oct. 23, 1878, xx, p. 56–62.

mentioning other species of beetles which had attacked the collection, as *Dermestes lardarius*, *Attagenus megatoma*, *A. pellio*, *Anthrenus varius*, *A. scrophulariæ* and *Ptinus fur*, he states:

Besides these beetles, I made the acquaintance of a pest which I at first entirely underrated, namely, *Tribolium ferrugineum*. The species is cosmopolitan, and as I never heard of damages done by it, I did not at once give it much attention. It was imported several times with large collections of insects from the East Indies. The flat body of the larva, as well as of the beetle, make it particularly fit to enter boxes through the smallest crack. As the collections were exceedingly large, it was impossible to take care of them immediately in a thorough manner, and I observed an alarming increase of the insect. It was rather difficult to overcome, but I succeeded by incessant care, by throwing away the worst infested insects, partly by killing individuals which I forced to come out of the body of specimens by filling the whole box with tobacco smoke. I saw the beetles and larvæ running out when the smoke began to fill the box, then I closed the box for an hour or two, when I found them all dead.

Confirmation of its Carnivorous Habits.

A carnivorous diet must be exceptional to this species and appears hardly to be recognized by our entomologists. A prominent coleopterist who had expressed his belief that it fed entirely upon vegetable material, even after he had been given the reference to the paper of Dr. Hagen, seemed unwilling to admit that it might at times assume carnivorous habits, offering in extenuation of the doubt, the fact that in museums and in the bindings of books, starchy materials are often to be found upon which insects may feed when they have credit for a different diet.

The observations of Dr. Hagen find abundant support in statements made by European writers. The following are some of them, referring to this insect.

Mr. Ingpen has discovered *Stenc ferruginea* in bran. "This species is more general in its habits than the preceding [*Tenebrio molitor*], since I have frequently discovered both the imago and exuviæ of the larva in the bodies of old and ill-preserved specimens of exotic insects" (Westwood, *Introduction Classif. Ins.*, i, p. 319).

In opening some paper envelopes of Lepidoptera received from Abyssinia, many of the specimens were eaten and had gone to pieces through the attack of *T. castaneum* [= *T. ferrugineum*]. The larva, pupa and imago were found and figured (Lucas, *Ann. Soc. Ent. Fr.*, 1855, ser. 3, vol. iii, p. 249).

The beetle and larva occur in old bread, when meal or flour are imported, and in stores of natural history specimens (Taschenberg, *Prakt. Insectenkund*, 1879, ii, p. 90).

Ordinarily found in meal and rice, but it attacks even collections of insects (Lacordaire, *Coleopt.*, v, p. 323).

Other Notices of the Insect

Mr. W. E. Saunders also makes mention of its carnivorous habits in Canada. He states that it infests patent food and similar substances, and that it eats the dead bodies of other beetles. (Insects Injurious to Drugs — *Canadian Entomologist*, May, 1883, xv, p. 82.)

Dr. Horn, in his Revision of the Tenebrionidæ of America, North of Mexico, *Trans. Amer. Philosoph. Soc.*, 1871, xiv, N. S., p. 365, merely groups it with its only known congener in our fauna, *C. madens* (Charp.), remarking of it that the former species is ferruginous, the latter black, and that in length, they vary from .16 to .20 inch, *C. madens* being the larger. Both are found abundantly wherever meal or grain is stored.

It is named in the list of Drs. LeConte, Horn, and Leidy, of "Insects Introduced by the Centennial Exhibition at Philadelphia," as occurring in mouldy specimens of straw goods from Italy.

I find no other notice of the species by our American authors.

The following interesting statement of its infesting a cargo of peanuts was communicated to the Entomological Society of London, by Mr. Albert Muller:

In the summer of 1863, a cargo of ground-nuts (*Arachis hypogæa*) arrived in the port of London, direct from Sierra Leone. On arrival the usual samples were drawn, when it turned out that the husks were riddled by countless holes, while the kernels were half eaten up by myriads of larvæ and imagines of *Tribolium ferrugineum*. So completely had they done their noisome work, that in the numerous samples examined scarcely an intact kernel could be found. If a nut was opened the whole interior was often found to be converted into a living conglomerate of larvæ, pupæ and imagines of *Tribolium*, accompanied by the larvæ and perfect insects of a *Rhizophagus* preying on the former, the whole mass being wrapped up in a layer of cast-skins and excrement.

Brachytarsus variegatus (Say).

(Ord. COLEOPTERA: Fam. ANTHRIBIDÆ.)

SAY: in Journ. Acad. Nat. Sci. Phila., v, pt. ii, 1827, p. 251 (*Anthribus*); Complete Works, Ed. Lec., 1869, ii, p. 314.

WALSH: in Journ. Ill. St. Agricul. Soc., 1862, pp. 8–12, figs.; in Proceed. Bost. Soc. Nat. Hist., 1864, ix, p. 309.

LECONTE: in Proceed. Amer. Philosoph. Soc., xv, 1876, p. 406.

Synonyms:

sticticus GYLL.: Schön. Curc., 1833, i, p. 172 (Brachytarsus).
obsoletus FAHRÆUS: Schön. Curc., 1839, v, p. 107.

Examples of this little Rhynchoporid beetle were sent to me under date of August 28, by Mr. C. A. Gillett, of Shortsville, Ontario county, N. Y., with this communication :

Depredations upon Wheat.

I send you with this mail a few specimens of an insect that I find in a bin of newly-threshed wheat. I also send a few kernels of wheat that were taken from the same bin. They show the work of an insect, presumably this one, in its growth from a larval state. Does it not seem that wheat is yet to be affected by this insect much as the pea is by the pea-bug? The few kernels inclosed with the bugs were thought to be perfect when put in the vial. If any marks are detected upon them, it must be owing to the eating of them by the bugs.

The sound kernels were found to have been eaten into when received; and during the following days that they were observed, the cavities increased in number and in size. There could, therefore, be but little doubt but that the burrowing of the wheat in the bin had been by this insect. The kernels taken from the bin showed different degrees of injury, from small rounded holes on the outer surface, to the excavation of nearly all of the interior.

It is not probable, however, that the fears expressed of serious injury to wheat by this insect are to be realized. It belongs to the Rhynchopora, or snout-beetles, and to the family of *Anthribidæ*, named from the Greek *anthos*, a flower, and *tribo*, to destroy. Most of the larvæ of this family find their food within the seeds and stems of plants.

The Larvæ of Brachytarsus Parasitic.

Dr. LeConte, in his "Rhynchophora of North America," Introduction, page xiv, remarks: While the food of the Rhynchophora is almost universally vegetable tissues, either living or dead, *Brachytarsus* is a parasite upon a Hemipteron, of the genus *Coccus*, as narrated by Nordlinger, *Stettin Ent. Zeitung*, 1848, p. 230; Lacord., *Gen. Col.*, vii, 481.

A species occurring in Europe, the *B. varius* Fabr., is known to live upon a *Coccus* infesting pine trees.

See also Prof. Westwood's remarks upon the parasitical connection of some of the species of this genus with the *Coccidæ*, in his Classification of Insects, i, p. 332.

The larvæ of this genus *Brachytarsus*, according to Dr. Le Baron, are found under the scales of bark-lice, where they are believed to be parasitic.

B. variegatus not a Wheat Pest.

It may, therefore, be inferred that the attack upon the wheat above noticed was not by the larva, and that the presence and feeding of the beetle was but accidental. It is known to be quite a general feeder, finding its food in various vegetable substances with which it may chance to be associated. Hence for the present, it will not be necessary to number *Brachytarsus variegatus* among the insect enemies of the wheat.

The attack was not a serious one. Upon inquiring of its character, Mr. Gillett informed me, that in looking over the wheat as it lay upon the floor, a perforated kernel could be found in an area the size of his hand, and more than twice as many of the beetles in the same space.

Description of the Beetle.

Appended is the original description of the insect as given by Mr. Say, together with his observation of its occurrence upon the smut of wheat, upon which it had probably fed.

A. variegatus. Varied, with blackish and dull yellowish; elytra, each with two larger spots.

Anthribus variegatus, Melsh. Catal.

Body dull ochreous, varied with blackish, with very short hair; *head* plane, dusky, paler toward the tip; antennæ moderate, pale rufous, three terminal joints fuscous; *thorax* much varied with blackish, which does not extend on the anterior margin; *elytra* with hardly obvious striæ, with many small orbicular, blackish spots, and two larger spots on each, of which one is near the sutural base, and the other rather beyond the middle, near the suture; *feet* pale rufous; thighs blackish in the middle.

Length more than $\frac{1}{10}$ of an inch.

The two spots of each elytron are sometimes united by an intervening blackish sutural line.

The species is not uncommon, and I have found it on the "smut" of wheat. Mr. Lea took eighty individuals from six heads of wheat.

Distribution.

This insect is generally distributed throughout the Atlantic States, associated with *B. limbatus* Say, from which the variety (*obsoletus*) in which the elytral spots are obsolete, may be distinguished by its more slender form.

Aramigus Fulleri (Horn).

Fuller's Rose Beetle.

(Ord. COLEOPTERA: Fam. OTIORHYNCHIDÆ.)

HORN: in Proc. Amer. Philosoph. Soc., 1876, xv, p. 94 (orig. description); in Canad. Entom., xvi, 1884, p. 184 (remarks on distribution).

RILEY: in Ann. Rept. Commis. Agricul. for 1878, pp. 255–7, pl. 7, f. 2; Id., Rept. Entomol., 1879, pp. 50–1, pl. 7, fig. 2 *a–h;* in Amer. Entomol., 1880, iii, p. 26 (occurrence in California); in Rept. Commis Agricul. for 1884, p. 414 (habits in Mass.).

COMSTOCK: in Ann. Rept. Commis. Agricul. for 1879, pp. 250–1 (distribution).

AUSTIN: Check List Coleop. N. A., 1880, p. 44, No. 8841.

LINTNER: in Count. Gent., xlix, 1884, p. 49 (remedies, etc.).

MOFFAT: in Canad. Entomol., xvi, 1884, p. 216 (occurrence in Canada).

During the month of December, last, this beetle was reported to me as occurring in great number in the extensive rose-growing establishment of Messrs. Fricker & Clarke, of Poughkeepsie, N. Y. It was proving very troublesome and destructive in their houses, and in the latter part of November, the beetles could be seen collected in large clusters upon the bushes. Many had been gathered and destroyed, but they still continued to abound.

That they should have been permitted to multiply to this extent was certainly inexcusable neglect.

A Green-house Pest.

This insect, during the last few years, has attracted considerable attention from the injuries committed by it in green-houses. It was first brought to my notice in the year 1874, by Mr. A. F. Chatfield, florist, of Albany, who had found the beetles eating the leaves of camellias in his conservatories and injuring the foliage. Soon after this, it appears to have been discovered in the same nefarious work in the green-houses of Mr. A. S. Fuller and other gentlemen in New Jersey. Examples of it were sent to Dr. G. H. Horn, of Philadelphia, who, in 1876, finding it to be an undescribed species and quite different from any known form, established a new genus for it, and gave it the specific name of *Fulleri*, after the gentleman who had first brought it to his notice, and who is also "a popular author on horticultural and natural history subjects, and well and widely known for his interest in entomology," especially in the Coleoptera.

Distribution and Food-plants.

Since that time, it has been reported from various localities in the

United States from the seaboard to the Pacific ocean, and from Canada. Its greatest injury is committed upon roses grown under glass, by the larvæ feeding upon the tender rootlets — at first merely checking their growth, but finally, when their numbers have increased, destroying the plant. It has also been observed upon the roots of *Geranium* and *Hibiscus*, and in California, is reported as "very destructive to *Dracænas* (and palms lightly), oranges, cape jessamine [*Gardenia*], and *Achyranthes*, in the order named." In Brantford, Canada, it has been found upon *Abutilon* and *Plumbago* in hot-houses. From Massachusetts, it is reported upon the *Azalea*, "Cissus," and "inch-plant."

Transformations of the Insect.

In the report of the Commissioner of Agriculture for 1878, the insect has been excellently figured in its four stages, and of the first three, scientific description is given. (Fig. 35 is from an electrotype obtained from the Department.) From the accompanying account by Prof. Riley, it appears that the eggs are laid in clusters of from ten to sixty, arranged in rows, which are artfully secreted between the bark and the trunk of the plant near its base, or occasionally between the ground and the trunk. Upon the hatching of the eggs (*c*) in about a month, the larvæ (*a*) burrow and begin their feeding upon the rootlets. When fully grown they change to pupæ (*b*) within the ground from which the perfect insects (*c*, *d*) emerge to pair, deposit their eggs for another brood, and to feed upon the leaves. Upon the under side of the foliage and the branches they may be found at rest during the day, as they are nocturnal in their habits, and only leave their concealment after dark for feeding.

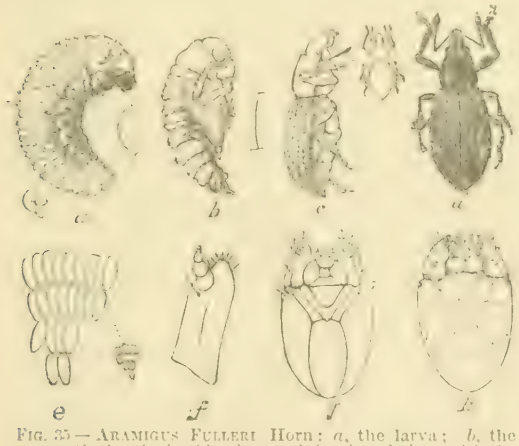


FIG. 35 — ARAMIGUS FULLERI HORN: *a*, the larva; *b*, the papa; *c*, the beetle, in side view, and *d*, a dorsal view, with the tarsi, mesothoracic legs, and antennæ detached and removed; *e*, mesothoracic leg, and antenna detached, enlarged; all in natural size; *f*, left maxilla with palpus; *g*, under side of head of larva; *h*, upper side of the same.

Description of the Beetle.

The following is the description of the beetle, as given by Dr. Horn, in *The Rhynchophora of America, North of Mexico*, loc. cit.:

Form oblong oval, surface not densely clothed with dark brown scales. Head and rostrum longer than the thorax, densely punctured,

sparsely scaly. Rostrum with feeble ridge on each side from the tip nearly to the eyes. Thorax cylindrical, apex and base equal and truncate, very slightly wider than long, sides feebly arcuate, a fine median line, disc moderately convex, densely punctured, sparsely scaly. Elytra regularly oval, humeri entirely obliterated, base sub-truncate, surface indistinctly striate, and with rows of large, moderately closely placed punctures, intervals flat, not densely scaly, and with very minute sub-erect hairs; scales dark brown, a whitish or paler stripe beginning at the humerus, passing along the lateral margin, ending in a short oblique fascia at the middle of the elytra. Body beneath sparsely scaly. Legs with scale-like hairs. Anterior tibiæ rather strongly denticulate within, articular surfaces of middle tibiæ not ascendant. Length, 0.26 inch; 6.5 mm.

Remedies.

The best method by which to meet the depredations of this insect, so far as known at the present, is to hunt for the beetles upon their food-plants, and to destroy them. If this be persistently done, the evil can be arrested. Mr. Chatfield informs me that by diligently searching for and killing all that he could find, for two or three successive years, he believes that he has exterminated them from his plant-houses, as he has not noticed them for the past two or three years.

Various experiments have been made with a view of killing the larvæ while preying upon the roots, but the opinion seems to prevail, as the result of such efforts, that it is only to be done at the sacrifice of the plant. A rose-bush which is known to be badly attacked at the roots had better be at once taken up and burned, and the soil that contained it treated with some caustic substance or with heat, to destroy such larvæ as may have been left behind.

If the eggs — which are described as smooth, soft, of a clear yellow color, and elongate-elliptical in shape — are carefully looked for in the places where they are usually hidden, they may be found and readily destroyed, and the injuries of the insect materially checked. Prof. Riley has recommended placing traps for the eggs, of pieces of paper or rags, wound about the trunks, or upon sticks thrust in the ground near them, to be collected at intervals of not exceeding three weeks, for the destruction of the eggs that may have been deposited upon them, by burning, or, if it is desired to use the traps again, by dipping them into hot water.

Cosmopepla carnifex (Fabr.).

(Ord. Hemiptera: Subord. Heteroptera: Fam. Cydnidæ.)

Cimex carnifex Fabr.: Ent. Syst. Suppl., 1794, p. 535, No. 162.
Eysarcoris carnifex Hahn: Wanz. Ins. ii, p. 117, f. 198.

Pentatoma carnifex KIRBY: Faun. Bor.-Amer. iv, 1837, p. 275, No. 1.
Cosmopepla carnifex STAL: Enum. Hemipt., ii, p. 19, No. 1.
C. carnifex. UHLER: in Bull U. S. G.-G. Surv. Terr., i, 1876, p. 18; id., iii, 1877, p. 402 (localities).
C. carnifex. GLOVER: MS. Notes Journ.—Hemipt., 1876, p. 35, pl. ii, f. 6.
C. carnifex. LINTNER: in Count. Gent., xxxix, 1874, p. 488, c. 1.

This insect is one of the true bugs, belonging, as above recorded, to the Heteropterous division of the Hemiptera, in which the wings instead of being deflexed are horizontal, the upper pair, or wing-covers, as they might more appropriately be called, are thickened or "leathery," with their tips thin and overlapping. The under wings are thin and membranous. The proboscis, rostrum, or sucker is much like that of the other Hemiptera, except that it springs from the front of the under side of the head instead of beneath it, posteriorly near the base of the fore legs.

Description.

The Imago. — The *C. carnifex* has much the general appearance of the Harlequin Cabbage-bug, *Murgantia histrionica*, noticed in my preceding report, having the same colors, but being a smaller insect, and proportionately broader in form. Its length is about 0.23 of an inch, and its breadth 0.17 in. The general color is shining black. The head, thorax and coriaceous portion of the wing-cases are granulated. The thorax is crossed by a transverse elevated ridge, marked with dull orange and is bisected by a slender mesial line of the same color. Coriaceous portion of wing-covers margined with orange, which is broader basally, thence becoming obsolete; margin of abdomen, also, orange. The scutellum is long, pointed, extending over two-thirds of the abdomen, and is marked with two triangular orange spots near the tip, one on each side. The antennæ, legs and proboscis are black. The insect enlarged from the natural size shown by the lines beside it, is represented at *b* in Fig. 36.

FIG. 36.—COSMOPEPLA CARNIFEX; *a*, the pupa; *b* the imago.

The Pupa. — The pupa, shown at *a*, is 0.20 by 0.16 of an inch in length and breadth. It is dull yellow, with the eyes, antennæ and legs (except their basal portion) black. The proboscis is black at the tip. The head has two longitudinal mesial black lines which diverge posteriorly. The thorax has a black line on its hinder margin, centrally, which is sometimes bisected at the middle, and also two rather large black spots, centrally on each side pointing backward and sometimes

connected with the black marginal line. A rounded black spot rests centrally on each side of the scutellum, and there is also a black dot near each anterior angle. The wing-pads are edged with black behind, and in addition they bear an S-like character in black, extending back centrally from the base. Upon the abdominal segments dorsally are two pairs of shining black points, of which the hinder pair are usually extended laterally into a line, and the front pair are sometimes connected; laterally, are four black dots marking the segments, which are also seen from beneath.

Not Hitherto Known as Injurious.

We find no record of injuries inflicted by this species upon any of our crops, nor notice of its habits by any of our economic writers. Mr. Glover, in his mention of it in his *Manuscript Notes from my Journal*, merely states in referring to a figure that he gives of it, "Insect probably destroys other insects." This supposition may have been drawn from the specific name which it bears, meaning "assassin," "executioner," "villain," or from the known carnivorous habits of *Podisus spinosus* (Dallas), *Perillus circumcinctus* (Stal), *Stiretrus anchorago* (Fabr.), and others, forgetting the very different habits displayed by the members of this large family — that the well-known cabbage pest, *Murgantia histrionica*, is a near relative of *C. carnifex*, belonging to the same sub-family of *Pentatomina*, and that another member of the same, *Euschistes variolarius* Pal. Beauv., feeds upon plants and animals interchangeably.

The Insect Attacks the Potato.

The insect in its larval, pupal and perfect stages, has been sent to me from Souyea, Livingston county, N. Y., about the middle of July, with the statement that they were injuring the vines, seriously, and that they were believed to be poisonous, as the vines, shortly after they had been punctured by the insect, withered and died. Paris green had been tried for killing, but to no purpose.

It also Attacks the Currant.

Subsequently, the mature insect has been sent to me for identification, by Prof. D. P. Penhallow, of McGill University of Montreal, Canada, as an injurious currant insect. It had appeared in large numbers in 1884, attacking the fruit, causing it to fall, and seriously injuring the crop.*

* It reappeared in still larger numbers the following summer.

Remedies.

As all the bugs belonging to the order of Hemiptera draw their food from the interior of the plant, sucking the sap by means of a proboscis thrust into the plant, it is useless to attempt to poison them by applications to the surface of the leaves. Many of them are so conspicuous in appearance, of so large size, and occurring often in not remarkable numbers, that their injuries to many of our low crops can be prevented by picking them off by hand, or by beating them from their food-plants by the aid of a short stick into a broad basin of water and kerosene.

When too abundant for this method, or in situations where they cannot be conveniently reached by hand, they will not be able to withstand thorough sprinkling with kerosene emulsions, so applied as to reach their breathing pores — a difficult matter perhaps in some of the species, which are so well protected by their close-fitting and broad wing-covers.

Its Distribution.

This species has quite a broad distribution over the United States. Mr. Uhler records it from Maine to Georgia, Texas, Indian Territory, Nebraska, Kansas, Missouri and Washington Territory; also from Port Neuf, Canada, and from Nova Scotia.

I have found it in large numbers, in former years, at Schoharie, N. Y., in the early part of July, upon some low plants (weeds?) — the species not recorded.

Is Probably not Carnivorous.

In the hope that the insect might, as a redeeming trait in its character, be induced to imitate the habits of some of its relatives, I made request of the gentleman from whom the specimens had been received, to confine them, after depriving them for a time of their vegetable food, with the larvæ of the Colorado potato beetle. The experiment was made, but as they showed no disposition to change their diet, during their trial of two days, it may be inferred that they are strictly vegetarian in their feeding.

Another Attack upon the Potato.

A singular attack upon the potato tuber may properly be recorded here, in connection with the above notice of a new attack upon the stems and leaves. It was brought to my notice several years ago (in 1877), by Mr. Miller, of the Austrian Commission at the Centennial Exposition at Philadelphia.

During his sojourn in the city of New York, he observed in many of the boiled potatoes brought upon the tables of the hotels and restaurants, upon being crushed by the knife, the remains of a channel or channels leading from the center to the exterior, which may have been the one-twentieth of an inch in diameter. They were apparently of uniform size, and often gave off two or three branches extending to the surface. From his imperfect use of the English language, I cannot assert positively that I quote him correctly in saying that the walls of the channels had such consistency as to permit of their cohesion after having been crushed so as to show their form and branching structure. The passages, he believed, in all cases, originated at the center, in a black spot. He regretted that his examinations had not been sufficiently minute to enable him to state with certainty whether the channels were entirely uniform in diameter, or if they enlarged somewhat with their outward extension, as is usual in the burrows of beetles made during their growth, and by interior-feeding lepidopterous larvæ. No animal remains were discovered within the tubes, the habit of the borer being, as was stated to him, to leave the potato while in the ground. The potatoes affected in this manner had been received from California, while in those coming from elsewhere, nothing of the kind had been noticed.

The gentleman believed it to be an insect attack, and from the evidence he gave of the ability to judge correctly in such a matter, it is probable that he was correct. But of the character of the insect, the time and the method of the introduction of the egg, no opinion of value can be offered.

Blissus leucopterus (Say).

The Chinch-Bug.

(Ord. HEMIPTERA: Subord. HETEROPTERA; Fam. LYGÆIDÆ.)

Lygæus leucopterus SAY: Heterop.-Hemip. N. A., 1831, p. 14; in Trans. N. Y. St. Agricul. Soc. (for 1857), xvii, 1858, p. 774.

Rhyparochromus devastator LE BARON: in Prairie Farmer, v, 1845, p. 287; id., ix, 1850, pp. 280–1.

Rhyparochromus leucopterus HARRIS: Treat. Ins. New Eng., 1852, pp. 172–3; Ins. Inj. Veg. 1862, pp. 197–199, f. 84.

Micropus leucopterus FITCH: in Trans. N. Y. St. Agr. Soc. for 1855, xv, 1856, pp. 509–529; 1st and 2d Rept. Ins. N. Y., 1856, pp. 277–297, pl. 4, figs. 2, 2a.

The Chinch bug, WALSH: in Trans. Ill. Agr. Soc. for 1859–60, iv, pp. 346–349, p. 436; in Pract. Entomol, i, 1866, p. 95 (barracading by tarred boards); ib., ii, 1866, p. 21 (in Canada).

Micropus (*Lygæus*) *leucopterus*. SHIMER: in Proc. Acad. Nat. Sci. Ph. for May, 1867, [xix], pp. 75–88 (injuries, habits, destroyed by an epidemic).

Micropus leucopterus. WLSH.-RIL.: in Amer. Ent., i, 1869, pp. 169–171, 194–199.

Rhyparochromus leucopterus. PACKARD: Guide Stud. Ins., 1869, pp. 543–4, f. 547; (as *Blissus leuc.*) in Ninth Rept. U. S. G.-G. Surv. Terr. for 1875, 1877. pp. 697–699, fig.; First Rept. Ins. Mass., 1871, p. 4.

Micropus leucopterus. BETHUNE: in Rept. Ent. Soc. Ont. for 1871, pp. 55–57 (general notice, and presence in Canada).

Micropus leucopterus. LE BARON: Second Rept. Ins. Ill., 1872, pp. 142–156.

Blissus leucopterus. THOMAS: Seventh Rept. Ins Ill., 1878, pp. 40–71; Bull. No. 5, U. S. Entomolog. Commis., 1879, pp. 44, figs. 10, and 1 map; in Amer. Entomol., iii, 1880, pp. 240–242 (influence of meteorological conditions).

Micropus leucopterus. RILEY: Seventh Rept. Ins. Mo., 1875, pp. 19–50, figs. 2–11; in Amer. Nat., xv, 1881, p. 820 (notice of a chinch-bug convention in Kansas); in Amer. Agricul., xl, 1881, p. 476, figs. 1–3; ibid., p. 515, figs. 1–4; in Science, ii, 1883, p. 620; in Rept. Commis. Agricul. for 1884, pp. 403–405.

Micropus leucopterus. GLOVER: MS. Notes Journ.—Hemipt., 1876, p. 489, pl. 2, figs. 16, 17.

Blissus leucopterus. UHLER: in Bull. U. S. G.-G. Surv. Terr., i, 1876, p. 306; in separate, as List of Hemip. West of Miss. Riv., p. 40 (distribution in U. S.)

Blissus leucopterus. FORBES: Twelfth Rept. Ins. Ill., 1883, pp. 32–63 (life-history, nat. enemies, parasites, remedies, etc.); in Bull. No. 2. Div. Entomol., U. S. Dept. Agricul., 1883, pp. 23–25 (experiments with kerosene emulsions).

Blissus leucopterus. LINTNER: in Albany Argus of October 10, 1883; in Count. Gent. for October 18, 1883, p. 841; in Science, October 19, 1883, ii, p. 540; Circular No. 1, N. Y. St. Mus. Nat. Hist., October 18, 1883, 3 pp.; in Thirty-seventh Ann. Rept. N. Y. St. Mus. Nat. Hist. [November, 1884], pp. 53–60.

During the last week in September of 1883, a package of insects in roots of grass was sent to the New York State Agricultural Society, by Mr. M. H. Smith, of Redwood, Jefferson county, New York, with the following statement in regard to them:

I herewith transmit specimens of (to us) a new and formidable grass-destroying insect, together with portions of grass destroyed by them, and also some of the soil, for the purpose of examination. If the insect is known to you, and there is any known way to exterminate it, please inform us at once. The evidence of its destructive work was first discovered in June of 1882, by Mr. H. C. King, of Hammond, St. Lawrence county. At haying time, about the middle of July, he noticed about three acres of his timothy grass to be apparently prematurely ripened. In the fall he observed that there was no aftergrowth, and that the stubble was as dead as if it had been boiled. Search was made among the dead roots without any discovery. The following spring the field was entirely barren of timothy, but some clover seeds and thistles occupied the ground where at least one and one-half tons of timothy to the acre, under favorable circumstances, would have been cut. In June of 1883, Mr. King discovered other fields to be affected in the same manner, and instituted a search which has recently resulted

in the discovery of myriads of the insect, not in the dead grass, but at the edge of the live grass, where they may be scraped up by handfuls. They have destroyed about fifteen acres for Mr. King and several acres for each of several other farmers of his vicinity. They are causing extreme alarm, and if you can give any relief from this calamity it will be gratefully appreciated. This is an important grazing locality. In addition to the timothy, June grass and wire grass are also destroyed.

The Insect Identified.

The insects being submitted to me by Secretary Harison, of the State Agricultural Society, they were at once, greatly to my surprise, recognized as the notorious chinch-bug of the Southern and Western States. It was the first instance of a New York specimen of the species coming under my observation, nor had I knowledge of its occurrence within the State, beyond the record of Dr. Fitch of his having met with three individuals of it. Dr. Harris had seen one specimen in Massachusetts. In each of the above instances, the occurrence was deemed of such interest and importance that the date of observation was given.*

The Insect Described.

It belongs to the order of Hemiptera, which comprises all of the bugs proper. It is, therefore, without biting jaws, but takes its food by suction through a four-jointed proboscis, which, when not in use, is bent beneath the body. Its size seems quite disproportioned to its destructive powers, being but three-twentieths of an inch long and one-third of its length broad. Its body is black and slightly hairy (a fine grayish down) under a magnifier. The wing-covers, resting flat upon its back, are white with a subtriangular black spot in the middle of the outer margin of each, and a few black veins upon their middle; the feet, claws and enlarged ends of the antennæ are black, while elsewhere the latter and the legs are dull yellow. Fig. 37 represents the insect.

Fig. 37— The Chinch-bug, Blissus leucopterus.

Although the injuries of this insect in wheat-fields in North Carolina were known over a hundred years ago, it was not until fifty years thereafter, that it received from Mr. Say, of New Harmony, Ind., a scientific name and description. It was referred by him to the genus *Lygæus*, and given the specific

*"The three specimens which I have met with in this State, occurred upon willows in the spring of 1847, and May 12th, 1851" (Fitch, *2d Report Ins. N. Y.*, 1856, p. 287).

"While this sheet is passing through the press [in which it is stated that the chinch-bug fortunately has not yet been observed in New England], I have to record the discovery of one of these bugs in my own garden, on the 17th of June, 1852" (Harris, *Insects Injurious to Vegetation*, 1862, p. 197).

name of *leucopterus*, meaning white-winged. The original description is as follows :

Blackish, hemelytra white with a black spot. Inhabits Virginia.

Body long, blackish with numerous hairs; antennæ, rather short hairs; second joint yellowish, longer than the third, ultimate joint longer than the second, thickest ; thorax tinged with cinerous before, with the basal edge piceous; hemelytra white, with a blackish oval spot on the lateral middle; rostrum and feet honey-yellow; thighs a little dilated. Length less than three-twentieths of an inch.

History of the Insect.

The very serious nature and the extent of the injuries resulting from this diminutive pest have drawn close attention and study to it, as appears in the many pages devoted to its history, transformations, habits, etc., by most of our principal writers in economic entomology. It has been properly characterized as "unquestionably one of the most pernicious insects which we have in the United States; the locusts of Utah and California being the only creatures of this class which exist within the bounds of our national domain, whose multiplication causes more sweeping destruction than does that of this diminutive and seemingly insignificant insect" (Fitch in 1855). It is but natural, therefore, that its literature should prove extensive, and that all that relates to its past history—its life-stages, habits and present status—means available for the control of its ravages, and the probabilities for the future, should be of deep interest to the agriculturist who is at all conversant with its destructive capabilities.

Dr. Fitch, in his second report, has devoted ten pages to its early history in this country. He states that appearing at the close of our revolutionary struggle, about the year 1783, in the interior of North Carolina, it was at first regarded as the Hessian fly, which at the same time was proving so destructive to wheat-fields on Long Island and in New Jersey. The insects continued to increase throughout North and South Carolina and Virginia for several years. As early as 1785 the wheat-fields in North Carolina were threatened with entire destruction. The ravages continued for several years thereafter, and the cultivation of wheat was temporarily abandoned.

In 1809 they again became so destructive in North Carolina that wheat was not sown for two years. But little was heard of them for a number of years thereafter, until in 1839, when they again became excessively numerous in Virginia and North Carolina, and extended their depredations to corn, oats and other grains. A writer states of them: "I have seen some of my corn so perfectly black with them for two feet up that no particle of grain was to be seen, but five or six inches of the

tips of the leaves; and they hung to the under parts of them in knots like little swarms of bees. It takes only one or two days to destroy the corn." In several instances entire fields were burned as the only known method of subduing the pest. The total destruction of the crops appeared inevitable, but most opportunely the season of 1840 proved to be an exceedingly wet one. The insect could not endure the rains, but died in myriads, and the attack was arrested.

At about this time the chinch-bug was noticed along the Upper Mississippi and in northern Illinois. Appearing simultaneously with the advent of the Mormons at Nauvoo (1840–1844), it was believed by many ignorant people to have been introduced by them, and the bugs were accordingly known as "Mormon lice."

It soon extended itself throughout all parts of Illinois and in adjoining portions of Indiana and Wisconsin. At this time, in Illinois in the middle of extensive prairies, upon parting the grass in search of other insects, Dr. Fitch found the ground swarming and covered with the bugs.

According to other writers, the insect appeared in 1847, in Iowa. In Indiana and Wisconsin, it was first observed in 1854 and 1855. In 1864, the crops in Iowa and adjoining portions of Illinois suffered severely from its attacks. In 1871 it spread in vast numbers over most of the North-western States, and again in 1874 it proved very destructive. In this latter year it was very injurious in Missouri, although its depredations had been serious in certain sections of the State in the years 1854–1857; its first recorded appearance there was in 1836.

The Common Name of the Insect.

Inquiry is not infrequently made of the origin and meaning of the popular name of this insect. Dr. Fitch has given this explanation: At first it was only the wingless larvæ which were supposed to be the depredators, they not having been associated with the mature form with its white wings. The larvæ have a close resemblance to the common bed-bug (*Acanthia lectularia*) formerly known as *Cimex lectularia*. Throughout the Southern States, the bed-bug is everywhere known by its Spanish name of *chincho*, and, therefore, when it was ascertained that the wheat depredator was not the Hessian fly, it came to be distinguished by the name of the *chinch*-bug.

Webster derives the Spanish *chincho* from the Latin cimex, and defines chinch, 1st, as the "bed-bug," and 2d, as "an insect or bug, resembling the bed-bug in its disgusting odor, which is very destructive to wheat and other grains; also called *chintz, chinch-bug, chink-bug.*"

Life-History.

Transformations. — The eggs are laid in the autumn upon the crown or the roots of the plants, where they remain throughout the winter and until the ground becomes warm enough in the following spring for their hatching. Or they may be laid in the spring by the bugs that were the later to mature and have hibernated in the perfect or in the pupal stage.* Occasionally clusters of the eggs are to be found above ground attached to the blades of their food-plants.

The eggs are so minute as hardly to be visible without a magnifier, measuring only about three-hundredths of an inch in length by one-fourth as broad. They are of a dull reddish color, elongate oval with the exception of being flattened at one end, where they bear four small tubercles, as at *a* and *b* in Fig. 38. About five hundred eggs are deposited by each female, at intervals, extending over several weeks. They hatch in about two weeks, when the larva appears at first of a pale yellowish color, but soon changes to red, except the two anterior segments of the body, and the legs, which are yellowish. In this stage it appears as shown in *c*. After the first molt, it becomes bright red, with a pale band across the middle of the body. After the second molt, the wing-pads begin to make their appearance, as at *f*, and the general color has become darker, with the pale band still conspicuous. Another molt brings it to its pupal stage, as at *g*, with distinct wing-pads; its anterior portions dark brown (fuscous), and its abdominal portions grayish, except the tip which is brown. The entire period required (when not interrupted by hibernation) for the transformations from the egg to the perfect insect, is from five to seven weeks.

FIG. 38.— EARLY STAGES OF THE CHINCH-BUG; *a*, *b*, eggs; *c*, newly-hatched larva; *d*, its tarsus; *e*, larva after first molt; *f*, same after second molt; *g*, the pupa; *h*, leg of mature bug enlarged; *i*, tarsus of same, more enlarged; *j*, proboscis or beak, enlarged.

The early brood. — During the months of May and June, but earlier in the Southern States, the hibernating individuals leave their retreats, and those that have not mated the preceding autumn, now seek their mates, soon after which the females proceed to lay their eggs upon the crown of the food-plant, or beneath the ground upon the roots, where the early life of the insect is, for the most part, passed. At this season

*Dr. Fitch has observed pupæ in October which he did not doubt would pass the winter in that state (2d Report, p. 291).

of mating, and again in the autumn, large numbers are frequently seen upon the wing, and it is believed by Dr. Shimer and others, that at no other time do they indulge in flight, except at these two nuptial seasons, which, in Illinois, occur in May and August (see *Proceedings of the Academy of Natural Sciences of Philadelphia*, for May, 1867). This, however, is certainly an error, for there is reliable evidence of their migration upon the wing, for other reasons, apparently, than from want of food. See the statement of immense swarms flying eastward, in Iowa, on and about the 19th of June, in Prof. Forbes' 12th *Report on the Insects of Illinois*, p. 34.

From the gradual development of the eggs within the ovaries, and the long-continued oviposition, it follows that the final maturity of the insect is far from uniform. Hence it is that it is found in such different sizes and stages at any time throughout the season. The ripening of spring wheat may be given as about the time that the larger portion of the brood has acquired wings. During the wheat harvest they are often very abundant.

The second brood. — In July, eggs are laid for a second brood, which, according to observations made in Illinois, by Prof. Forbes, in 1882, were hatched about the middle of the month. Matured individuals were seen, the first, on August 8th; by the last of August, about one-half of the brood had matured, and the entire brood had become winged by the middle of September; by the 25th of September they had apparently ceased feeding. On the 3d of October they were rare in the corn-fields, and had evidently scattered in search of winter quarters.

As a general rule, this brood is less injurious than the first, as the corn and their other food-plants are more advanced and better able to resist attack.

Hibernation.—At the approach of cold weather they cease feeding, desert their food-plants and seek sheltered places where they may pass the winter. Some of them merely crawl down the stalks and stems and enter the ground, burying themselves therein to a moderate depth. Others take wing in search of secure retreats in any rubbish that may be found upon the borders or in the vicinity of the field, such as logs, old fences of wood or stone, coarse weeds, heaps of straw, leaves, etc. Stacks and piles of corn-stalks are particularly attractive to them, and are often employed as a lure, to serve as a holocaust later in the season for the myriads that have sought their shelter. Woodlands near the fields where they have abounded, furnish harborage for large numbers during the winter.

In the torpid condition in which they hibernate, they are capable of enduring an extreme degree of cold, and may even be frozen, it is said, without suffering harm.

A Dimorphic Form of the Chinch-Bug.

In addition to the ordinary form described and figured on page 150, there is also to be met with in limited numbers in some localities, a "dimorphic" form which has been characterized by Dr. Fitch as one of nine varieties observed by him, under the name of var. *apterus*. It is shown in figure 39. Prof. Riley has remarked of this and allied forms:

FIG. 39.—The Short-winged Chinch-bug.

"There are, as is well known to entomologists, many genera of the half-winged bugs, which in Europe occur in two distinct or 'dimorphous' forms, with no intermediate grades between the two, viz., a short-winged or sometimes a completely wingless type and a long-winged type. Frequently the two occur promiscuously together, and are found promiscuously copulating, so that they cannot possibly be distinct species. Sometimes the long-winged type occurs in particular seasons, and especially in very hot seasons. More rarely the short-winged type occurs in a different locality from the long-winged type, and usually in that case in a more northerly locality. We have a good illustration of this latter peculiarity in the case of the chinch-bug, for a dimorphous short-winged form occurs in Canada, and Dr. Fitch describes it from specimens received from the States as a variety under the name of *apterus* (*Second Report on the Insects of Missouri*, 1870, p. 22, f. 2; also, *Seventh Report on the Insects of Missouri*, 1875, p. 20, f. 4).

Of a number of specimens sent to Mr. B. D. Walsh for identification, from Canada, in 1866, which had been taken from under the bark of an old log, all (eleven) were of this form, and were regarded by him as a "geographical variety" (*Practical Entomologist*, ii, p. 21)

FIG. 40.—Wing-covers and wings of the chinch-bug, and its short-winged form, showing their nervulation: 1, wing-cover of normal form; 2, wing of the same; 3, wing-cover of short-winged form; 4, wing of the same. Enlarged to 18 diameters.

The same form was remarkably abundant among the specimens sent to me from Jefferson county, by Mr. Smith, and in those that were

subsequently obtained by me upon the farm of Mr. King. At least twenty per cent of the entire number were of this form. The varietal name given it by Dr. Fitch is misleading, for none of them probably are wingless. Both the wing covers (hemelytra) and wings are very much shortened — the former usually to about one-half the normal length, and the latter to not much exceeding one-third. In figure 40, the relative size of the two is shown, together with the structure of each, from preparations and careful camera drawings made for this paper by Mr. C. E. Beecher. As the drawings are intended to represent structure only, the characteristic pigment spots and markings of the wing-covers are not given. Their coriaceous portion shows numerous short hairs, not extending beyond — the crinkled lines appearing elsewhere, and upon the wings, resulting from the unequal distension of the wing-membranes by the nerves. A comparison of the nervulation in the two forms cannot fail of being of interest to the student

Injuries of the Insect.

The chinch-bug is beyond all question one of the most destructive of our insect pests. It has been justly said of it: "The locusts of the west are the only creatures of this class which exist within the bounds of our national domain, whose multiplication causes more sweeping destruction than does that of this diminutive and seemingly insignificant insect."

Another writer, who has given it patient study, has remarked of it: "It is the most dangerous insect foe with which we have to deal. That it taxes them more heavily than all other such enemies combined, is burnt into the convictions of thousands of farmers by repeated heavy losses and bitter disappointment" (Forbes).

Throughout the Southern and Western States, or more properly, those lying within "the wheat-belt region," the chinch-bug is a well-known and dreaded enemy, from the almost incredible amount of injury which it inflicts, in certain years, upon the grain and corn crops. Probably the aggregate of pecuniary losses which have resulted to the United States from its ravages have considerably exceeded those inflicted by any other of our thousand insect pests.

That some idea may be had of the amount of these losses, a few of the more reliable estimates that have been made are herewith presented.

Mr. Walsh estimated the loss from the insect in Illinois alone, in the year 1864, at over $73,000,000, while a careful computation made by Dr. Shimer, for the same year, showed that in the extensive wheat and corn-fields of the valley of the Mississippi, three-fourths of the wheat and one-half of the corn was destroyed at a loss of more than $100,000,000, in the currency that then prevailed.

Dr. Le Baron, from data collected with great care, has estimated the value of the wheat, oats, barley and corn destroyed in the State of Illinois in 1871, at ten and a half millions of dollars; and for the six additional Western States of Iowa, Missouri, Indiana, Kansas, Nebraska and Wisconsin, approximately, double that of Illinois, making an aggregate in the North-western States of over $31,000,000 (*Second Report on the Insects of Illinois*, 1872, p. 144).

Prof. Riley, from county returns received from eighty-six counties in the State ot Missouri, and from estimates of the remaining twenty-eight counties, has calculated the loss to the three staple crops of wheat, corn and oats alone, in 1874, in that State, at $19,000,000. He also states that during this year the losses from the same insect in Illinois may be safely put down at double that they were in 1871, or over $60,000,000 (*Seventh Report on the Insects of Missouri*, 1875, pp. 24, 25).

The years 1864, 1871 and 1874, from the warm and dry seasons that they offered, were unusually favorable to the multiplication of the insect, and were therefore years of its unusual abundance. Still it is not of rare occurrence that a single one of the wheat-growing Western States should suffer a loss of $10,000,000 in a single year. It seems almost incredible that the destructive powers of a small suctorial insect could be so great, but its enormous numbers must furnish the explanation. In times of its abundance it is so numerous as to cover the ground; it blackens the stalks of the plants upon which it feeds; it fills the air when at seasons of its mating, it takes wing for flight; it marches to new feeding-grounds in solid bodies, upon and over one another; its invading armies sweep over and utterly destroy a wheat or corn-field in two or three days; and the nauseous bed-bug odor which they exhale sickens those who are compelled to breathe it.

Only a little of our knowledge of this insect has been given in the preceding pages, but that space may be left for some notice of its recent operations in the State of New York, those who would know more of its interesting history, its habits, the natural enemies that prey upon it, and the various means used for destroying it, are referred to the excellent and extended papers upon it by Harris, Fitch, Thomas, Riley, Forbes and others which we have cited.

Operations in New York.

Its presence in New York in the years 1882 and 1883, while not attended with serious losses, was justly the occasion of great anxiety and fears. The attack, under its existing conditions, was of so threatening a character that I deemed it my duty to recommend most earnest efforts for its suppression. Just how far the efforts made in compliance with the recommendations aided in its arrest can only be surmised.

The following were my reasons for believing that the attack would continue and become more serious, as contributed to the *Albany Argus* of October 10, 1883:

The insect has planted itself, maintained a footing and has shown a rapid increase under unfavoring, unpropitious and unnatural conditions such as these:

First. It is regarded as a southern insect (extending farther northward, as do most animal forms, in the Mississippi valley), yet it has appeared in the most northern county of the State, and upon, if the report be reliable, the St. Lawrence river.

Second. Its attack has been made upon timothy. This seems to be its most unusual food-plant, and, therefore, we infer, the least suited to it. All previous accounts concur in giving it a preference for spring wheat above all things else; next in order, oats or corn, and last the grasses. Timothy is only mentioned as occasionally attacked by it.

Third. In all previous accounts, great prominence has been given to its being a hot and dry weather insect, dependent upon these conditions, not only for its multiplication, but for its existence. Heavy rains have been claimed to be invariably fatal to it. It could not abound, it is stated, in a wet season. Dr. Fitch had even made recommendation of sprinkling it with water (an artificial shower), as the best means for its extermination. In the present instance, the bug obstinately persists in multiplying, contrary to all rule. The past year and the present have both been years of excessive rain-fall in St. Lawrence county. Spring, summer and autumn have been exceptionally wet. In the spring, heavy and continued rains flooded meadows now showing the chinch-bug attack. At haying time, when the bugs were young, and according to all the statements hitherto made, readily killed by wet, the rains were so frequent and severe, that the grass cut could only be secured with difficulty. Upon Mr. King's farm, much of it was drawn in, upon favorable days, by improving the opportunity of extending the labor into hours after nightfall. At the present time grass is lying in fields in stacks, which could not be gathered, owing to continued rain; and fields of oats are still unharvested.

It appears that the insect has rapidly increased and largely extended its area during the present year, under conditions which should have been fatal to it. Why it has been otherwise may perhaps find its explanation in the fact that it is a new introduction into this part of the United States, and that it is following the law well known to prevail in the introduction from abroad (Europe principally), of nearly all of our injurious insects. With scarcely an exception, with their importation, they become far more destructive, causing greater ravages and often attacking new food-plants.

As the past history of the insect has shown that parasites and other enemies have entirely failed to arrest its multiplication, we are compelled to believe, from present indications, that it has come to stay, and that it will do so, unless effectual means are taken to prevent it. Its capability of increase is wonderful. Under the most conservative circumstances, a single chinch-bug, depositing its eggs about the first of June, would be, in the following August, the progenitor of a quarter of a million.

It should not be necessary to urge the importance of doing whatever can be done to arrest this attack, which threatens to be more serious to New York than was that of the wheat-midge, the loss from which, in some years, was computed at $15,000,000. If it should continue to increase it will doubtless extend to wheat, and corn and other of the grains. In its southern extension in this State it would naturally become more serious. At the present it is known in but two counties — Jefferson and St. Lawrence. It seems practicable by prompt, earnest and combined effort, to prevent its extension and to check it where it now exists.

Observations upon the Attack.

In addition to the information contained in the communication of Mr. Smith, given on page 149, I am able to add the following, from my personal observations, made during a visit to Hammond, and on inspection of the infested farm of Mr. King, on October 5th and 6th. The cold weather of the preceding few days (ice was formed upon three nights) had doubtless driven most of the bugs to their winter quarters for hibernation in crevices, beneath boards, rails, etc., in rubbish heaps, and to many other secure retreats where such insects are accustomed to hide. Yet upon parting the roots of the timothy upon borders of the killed portion in one of the fields they were found in alarming numbers — in some spots sufficient to cover the ground with their bodies over an area of two or three inches in diameter, having perhaps congregated for warmth in such places. In one spot, upon the warm slope of a dead furrow, they could be seen, in large numbers, running like ants over the ground. Elsewhere, they were concealed among the roots, near to and about the bulbs, upon which they appeared mainly to feed. Their presence in any spot could always be detected by bringing the nose near the ground by the peculiar bed-bug odor that they exhaled. This method of detection proved more convenient and infallible than looking for them.

The territory occupied by them was more extended than was at first supposed. Nearly all of the farms in the neighborhood of Mr. King had been attacked, some of them the preceding year, and discoveries of attack not before suspected were, upon examination, being made daily. A range, at the time, of about eight miles was indicated. It was believed to occur throughout most of the town of Hammond, and to extend into Alexandria upon the St. Lawrence river.

The following are a few of the memoranda (the remainder lost) of the number of acres showing the attack in the town of Hammond, upon farms in the immediate vicinity of Mr. King, which were made at the time of my visit:

Mr. H. C. King, sixteen acres of timothy and clover; cut on the 5th of July; the attack first noticed in August; more than one-half of the

timothy was eaten. On another portion (upland) of his farm, three acres of timothy, and in another, twelve acres of meadow were eaten.

Mr. E. J. White, first noticed the injury in September of 1882, in the killing of the timothy upon a spot between two and three rods square. In 1883, it was again observed after haying in July, and continued to extend, and to appear in three other places — in all, seven or eight acres.

Mr. Keller Dygert, adjoining Mr. King's farm, over six acres destroyed.

Mr. Robert Rogers, five or six acres of timothy very badly injured.

Mr. Robert Broidee, a meadow badly infested, but extent not stated.

Mr. Abel Pickett, a small spot, commencing the previous year, and is steadily extending.

Mr. Wm. Cuthbert's farm, five miles from Mr. King, near the St. Lawrence river, reported as showing the attack of the insect.

Mr. Thomas B. Phillips had two acres injured the preceding autumn; present area considerably larger but not given.

Mr. Charles Fitch, of the town of Morristown, six acres destroyed.

A wheat-field of Mr. King seems to have been infested, but to have been checked by its roots having been submerged by a heavy rain-fall continuing for several days.

The insect is reported on the farm of Mr. Cook, in the town of Champion, Jefferson county, in the vicinity of Pleasant lake, and near the northern line of Lewis county.

Measures Recommended to Arrest the Attack.

In view of the severity of the attack, and the seeming need of earnest efforts to arrest it, it was thought proper that general attention should be called to it throughout the infested region, and instructions given as to the best means for arresting it, particularly to such as could be at once resorted to, in order to reach as large a portion as possible of the autumnal brood. A circular giving such information was accordingly prepared, and an edition of three thousand copies printed and distributed throughout the portions of the State where the attack was observed, together with such contiguous territory as it might be expected to reach in another season.

As a portion of the history of the attack, and as containing directions which would be of service in future appearances of the insect in New York or in the New England States, the circular is herewith given:

Circular No. 1 — October, 1883.

NEW YORK STATE MUSEUM OF NATURAL HISTORY,
DEPARTMENT OF ENTOMOLOGY.

Directions for Arresting the Chinch-bug Invasion of Northern New York.

Portions of St. Lawrence county, New York, are now suffering from a serious attack of the chinch-bug (*Blissus leucopterus*) — perhaps the most injurious of our insect enemies.

It has already, in the third year (probably) of its introduction, and the second year of the observation of its attack, spread to such an extent, and shown such a rapid increase under very unfavorable conditions, that a continued increase in its diffusion and destructiveness is probable, unless effectual measures can be taken to prevent it.

At present, only timothy and other grasses seem to have been attacked. Wherever attacked, the root is destroyed, and the grass, consequently, is entirely killed.

With its increase, its ravages would extend to wheat, rye, barley and corn, which are its favorite food-plants.

Its extension over the State of New York, as now threatened, would be attended with an annual loss of millions of dollars.

It seems practicable, at this stage, to prevent this extension, by earnest and combined effort throughout the district now invaded.

The most favorable time for this effort has already passed; but much may be accomplished by immediate action.

As it is of very great importance that this destructive insect — the terror of our Southern and Western farmers — should not be permitted to obtain a permanent footing in our State, hitherto free from its depredations, a prompt and full compliance with the following directions is strongly urged:

1. Let every farmer in St. Lawrence county and adjacent counties in Northern New York (particularly in the western portion of St. Lawrence and northern of Jefferson), examine his meadows for patches of dead grass, looking as if winter-killed, indicating the attack of the insect. As an aid to its ready recognition, the infested areas upon the farm of Mr. H. C. King, of the town of Hammond, St. Lawrence county, may be examined.

2. If the attack is detected, burn the dead grass and its surrounding border of fifteen or twenty feet not yet showing attack. This may be effectually done by first applying a covering of straw. A favoring wind is desirable for the purpose.

3. Plow the burned area (better still if the plowing extends beyond this limit and embraces the entire meadow) in broad and deep furrows, turning the sod completely and flatly over, not permitting it to lie in ridges.

4. To insure the more effectual burying of the insects that may be at present feeding upon, or preparing to pass the winter among, the roots of the grasses, harrow the plowed surface slightly, and follow with a heavy rolling.

5. Where the meadows will not permit of plowing as above, gas-lime, wherever it can be conveniently obtained from the gas-works at Ogdensburg, Watertown, etc., may be distributed over the ground, at the rate of two hundred bushels to the acre. The gas-lime would also serve as a valuable fertilizer.

Of the above directions, the first four should be followed *at once.* The application of gas-lime might be postponed until the month of November, before the setting in of winter, or to the early spring. It should be confined to the dead and infested portions of the meadows, as in its fresh state it would kill the grass. In the winter, during February, it may safely be distributed over the entire fields, where it would probably serve the additional purpose of a preventive of a spring attack.

New attacks and more widespread distribution may be looked for about the first of June in the ensuing year. Directions for meeting these, by other methods, will be given hereafter.

It is hoped that every one interested will cheerfully comply with the above directions, and not render necessary a resort to compulsory legislation, which would undoubtedly call for a large increase of labor and expenditure. The agricultural interests of the State of New York may justly demand that, if possible to prevent it, the chinch-bug shall not be allowed to gain a permanent footing as a grain and grass destroyer within its borders. Its injuries in the State of Illinois, in a single year, were estimated at $73,000,000 — almost five times the amount computed for the wheat-midge ravages in New York, at the time of its greatest destructiveness.

Office of the State Entomologist, *October* 18, 1883.

To the above circular the following figure (after Fitch), and description was appended, to aid in the recognition of the insect.

The Chinch-Bug in natural size and as enlarged (about ten diameters). Color: black, with white wing-covers, having a black subtriangular spot on the outer margin of each, and two black veins nearer the base. The legs, the sucking-tube, and the base of the antennæ, are deep honey-yellow; the feet and the last joints of the antennæ are black. Length, about three-twentieths of an inch.

The young, appearing early in June and late in August, are blood-red, with a white band across their middle: later they change to brown and afterward to black.

Remedial Measures Employed.

In a report made by me to the Regents of the University of the State of New York, under date of January 8, 1884, and published in the Thirty-seventh Annual Report on the State Museum of Natural History, in referring to the above circular I stated as follows :

I regret to have to report that the response given to the directions of the circular have fallen short of their requirement. Plowing under the infested areas has been quite general, but I do not learn that it has approached the thorough character recommended. Burning has not been resorted to, except upon the farm of Mr. King. The application of gas-lime will probably not be made, to any great extent, as it is reported as not easily to be obtained. Perhaps no other result should have been anticipated at this stage of the attack, or before the absolute necessity of vigorous action should be unmistakably apparent. Former experiences show that our farmers, as a rule, are indisposed to yield ready compliance with recommendations simply, although calculated to save them from serious pecuniary loss, particularly if such recommendations involve any expenditure beyond that of quite a limited amount of extra labor on their part. It would, therefore, seem to be a wise economy for the State, whenever a continued extension of any formidable insect attack presents itself, that a prompt resort be had to effectual preventive measures, through legislation compelling the action desired and not otherwise to be had. Several laws for the prevention and destruction of injurious insects exist upon the statute books of European countries. In our own State and others there are laws against noxious weeds; and it would indicate enlightened progress if there were also those controlling the unlimited spread of some of our more harmful insect pests.

Cessation of the Attack.

Although the insect was reported by Mr. King to have been found by him, in alarming nnmbers, late in October, hidden beneath rails, chips, bark, etc., yet the apprehension of its increase and spread in the spring of 1884 was not realized. Doubtless the general plowing of the infested lands aided materially in its destruction; yet to the more effective operation of natural causes, such as the extreme cold of the winter or the early spring rains, or other unfavorable meteorological conditions, must be credited, mainly, the arrest of the attack, either through the death of the mature insects during the winter, or that of their progeny in the early spring.

So far as I could learn, the insect did not reappear to the extent of committing serious injury. In localities where it had abounded the preceding year, and the land had not been plowed, its presence, in hibernated individuals, was observed as soon as the snow was gone. No further damage was reported to me, except in one instance where no attention had been paid to the recommendation of thorough autumn plow-

ing. Here a piece of wheat of several acres in extent was attacked, and considerably injured by it.

Observed in other Northern and Eastern Localities.

During the spring of 1883, the insect also occurred abundantly in at least one locality in Massachusetts, for according to Dr. George Dimmock, "on the 28th of March, the lowland between Belmont and Cambridge was swarming with them" (*Psyche*, Novem.-Decem., 1883, iv, p. 119).

An earlier observation of it in Massachusetts has been communicated to me by Dr. Packard, in the following extract from his diary: "June 17, 1871, at Salem, Mass., chinch-bugs with wing-covers extending over the basal third of the abdomen, seen in copula, end-to-end." Dr. Packard has also published the fact of his having taken the insect "frequently in Maine and even on the extreme summit of Mt. Washington in August" (*Guide to the Study of Insects*, 1869, pp. 543–4).

Mr. Henry L. Fernald, of Orono, Maine, who is making special study of the Hemiptera, has given me the following memoranda of its occurrence at Orono, latitude 44° 40′: "One example captured in 1879; one on May 25, 1880; three on June 3, 1882. Since that time quite common in June; taken in all cases by sweeping over grass."

Its occurrence in Canada, in 1866, in a few examples has already been referred to (page 155). Upon inquiry, I learn that the locality of their collection by Mr. J. Pettit, was at Grimsby.

For a still more northern locality of the insect we are indebted to the recent collections of Mr. W. H. Harrington, of Ottawa, Ont., who, at the annual meeting of the Entomological Society of Ontario, at London, in October of 1884, exhibited specimens of the chinch-bug which he had found abundant at Sydney, Cape Breton (N. latitude 46° 18′) during a visit there in September (*Canadian Entomologist* for November, 1884, xvi, p. 218).

Largus succinctus (Linn.).

The Margined Largus.

(Ord. HEMIPTERA: Subord. HETEROPTERA: Fam. PYRRHOCORIDÆ.)

Cimex succinctus LINN.: Syst. Nat., ii, 1767, p. 727, No. 82.

Cimex rubrocinctus DE GEER: Mem. Hist. Ins., iii, p. 339, No. 13, pl. 34, f. 19.

Cimex succinctus FABR.: Spec. Ins., ii, 1781, p. 369, No. 185; Syst. Ent., 1775, p. 723, No. 133; Mant. Ins., ii, 1787, p. 303.

Lygæus succinctus FABR.: Ent. Syst., iv, 1793, p. 170.

Largus succinctus HERR.-SCH.: Wanz. Ins., vi, p. 78, f. 648.

Capsus succinctus var. A. SAY: Heterop. Hemip N. A., 1831, p. —; in Trans. N. Y. St. Agricul. Soc., xvii, 1858, p. 783.

Largus succinctus. GLOVER: in Rept. Comm. Agr. for 1875, 1876, p. 124, f. 28; MS. Notes Journ.—Hemipt., 1876, p. 43, pl. 1, f. 12; MS. Notes Journ.—Cotton Insects, 1878, pl. 16, f. 9 (note to figure).

Largus succinctus. UHLER: in Bull U. S. G.-G. Surv. Terr., i, 1876, p. 315; List Hemiptera W. Miss. Riv., 1876, p. 19; Stand. Nat. Hist., v, p. 288, f. 331.

Largus succinctus. LINTNER: in Count. Gent., xlvi, 1881, p. 663.

The injurious habits of this species have only, up to the present, been noticed in Texas. A letter received from San Antonio, represents it as quite annoying in a peach orchard, from its working into the fruit and spoiling it just before its time of ripening.

Distribution and Variations.

Although not as yet recorded from the State of New York, it without much doubt occurs within its limits, as it is found in Pennsylvania and New Jersey, and has a broad distribution over the United States. Mr. Uhler gives as its habitat, "Pennsylvania to Florida, and westward to Texas, Arizona and southern Colorado. The western specimens are blacker and not so brightly red-margined as those from the coasts of Georgia and Florida. In the sea islands of the latter a variety occurs which is of a dirty sand-red.

"The genus is essentially American, and ranges between the northern warm-temperate zone and the southern warm-temperate zone. The insular and equatorial ones of the lowlands are marked with yellow spots, while the others are more uniform and plainer in their pattern."

Its Appearance.

It bears a marked resemblance to the common squash-bug, *Anasa tristis* (De Geer), Fig. 42, in size and form; the thorax is very nearly the same in shape. It measures one-half of an inch in length by one-fifth in breadth, is of a rusty black color, with the thorax and upper wings freckled and broadly bordered with red. The brief diagnosis of Fabricius gives its characteristic features: "Oblong, the thorax, margin of the elytra, and base of the femora red." The diagnosis of De Geer adds to the above, "ashy-black, femora toothed in front." The insect is represented in Fig. 41. The variety described by Say, as inhabiting Mexico, has the "surface paler, with numerous black punctures, giving a dusky appearance; origin of the antennæ and a line on each side of the origin of the rostrum sanguineous." Uhler has referred this variety to *Largus cinctus* Her.-Schf., which as it differs only in a slight degree from

FIG. 41. — The Margined Largus, LARGUS SUCCINCTUS — enlarged one-half diameter

and beak still more enlarged.

L. succinctus, "will no doubt hereafter prove to be only the western form of it." This would extend the range of the species into California, Oregon, Nevada and Arizona.

In its early stages, according to Uhler, it is of a brilliant steel-blue color, with reddish legs, and a bright red spot at the base of the abdomen.

Habits.

Scarcely any thing is known of the habits of this insect, as it has not engaged the attention of our economic entomologists. Mr. Glover had found it hibernating in Maryland, under moss, stems and bark in mid-winter but had never seen it injuring plants. In the same State and in Virginia, the adults have been observed along the borders of oak-woods in the months of July and August. It also occurred in the southern cotton-fields, occasionally upon the bolls, but commonly on the ground and under stones. It had been represented as stinging severely with its proboscis and as destroying other insects.

It is closely allied to the well-known red-bug or cotton-stainer of the Southern States, *Dysdercus suturellus* Her.-Schf.,* which is so injurious to cotton, in sucking the sap from the plants and the bolls, and staining the fibres of the opened bolls indelibly with their excrements, to the extent of greatly impairing the market value of the cotton.

Other members of the family, although less nearly allied to it than the above, and therefore of but little value in indicating habits, are the chinch-bug, *Blissus leucopterus* (Say), the false chinch-bug, *Nysius angustatus* Uhler (= N. destructor *Riley*), and *Lygæus turcicus* Fabr.—the latter a common New York species, found abundantly upon milk-weed (*Asclepias*), during the month of August, and said to have been seen feeding upon the caterpillars (? *Euchetes egle*) infesting the plant.

The habits of a European species *Pyrrhocoris calmariensis* Fallen, from its near relationship, are probably much like those of *L. succinctus*. Prof. Westwood had found them swarming in gardens in the neighborhood of Berlin, where they were engaged in sucking fallen berries and seeds, as well as such of their companions as had been trodden under foot (*Introduc. Classif. Ins.*, ii, p. 481, fig. 121, 8, 9). Hausmann had observed their partiality for dead insects, and that they would not attack living ones.

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*See Glover's "MS. Notes from my Journal—Cotton and the Principal Insects Frequenting or Injuring the Plant," 1878, where the transformations, structure and habits of the insect are illustrated in the fourteen figures of Plate XVI, and mention is made of the cotton plants near Jacksonville, Florida, in 1855, being literally colored red with the multitudes that were crawling over the stalks, leaves, and bolls.

Remedies.

There is but little probability that this insect will become particularly injurious to peaches or to other fruits. From the little that is known of its habits, and from what may be inferred from related species, it will rarely, if ever, ascend trees in search of food, but will prefer to seek its food upon the ground.

It would be difficult or impossible to devise a preventive of its attack, as its suctorial habits preclude the beneficial use of external applications to the fruit. It remains, therefore, in the event of its abundance and threatened injuries, to find means for destroying such numbers as to lessen the amount of its depredations. It is probable that the same methods that have been employed with beneficial results for the destruction of the cotton-stainer, as given by Mr. Glover, will also serve for this: "These insects being in the habit of collecting together where there were splinters or fragments of sugar-cane on the ground, advantage was taken of this fact to draw them together by means of small chips of sugar-cane laid upon the earth near the plants, when they were at once destroyed by boiling water. They also collect around heaps of cotton seed where they may readily be destroyed at the commencement of cold weather. Small heaps of refuse trash, dried cornstalks, or especially of crushed sugar-cane, may be made in various parts of the plantation in the vicinity of the plants. Under these the insects take shelter from the cold, and when a sufficient quantity of the bugs are thus drawn together the various heaps may be fired, and the insects destroyed with the trash. A very cold morning, however, should be selected, and the fire made before the insects have been thawed into life and vigor by the heat of the sun; and especially all dead trees, decayed stumps, and weeds in the vicinity of the field should be burned or otherwise destroyed, as they afford a comfortable shelter for all sorts of noxious insects, in which they can pass the winter in a semi-dormant state."

Cicada septendecim Linn.

The Seventeen-year Locust.

(Ord. HEMIPTERA: Subord. HOMOPTERA: Fam. CICADIDÆ.)

LINNÆUS: Syst. Nat., i, pt. ii, 1767, p. 708, No. 20.

FABR.: Syst. Ent., 1775, p. 679, No. 6; Spec. Ins., ii, 1781, p. 319, No. 6; Mant. Ins., ii, 1787, p. 266, No. 9 (*Tettigonia septendecim*).

HILDRETH: in Silliman's Amer. Journ. Sci.-Arts, x, 1826, pp. 327–329 (emergence, oviposition, injuries, etc.).

MORRIS: in Proc. Acad. Nat. Sci. Phil., iii, Nov., 1846, pp. 132–134; Ib., March, 1847, pp. 190–191 (larvæ on roots of fruit trees); in Downing's Horticulturist, ii, 1847, p. 16.

BURNETT: in Proc. Bost. Soc. Nat. Hist., iv, 1851, p. 71 (sexual system and musical apparatus); Ib., p. 111 (appearance in cleared lands).

HARRIS: Ins. N. Eng., 1852, pp. 180–189; Ins. Inj. Veg., 1860, pp. 206–217, f. 87, pl. 3, f. 7.

FITCH: in Trans. N. Y. St. Agricul. Soc. for 1854, xiv, 1855, pp. 742–753; 1st Rept. Ins. N. York, 1856, pp. 38–49.

WALSH: in Pract. Entomol., i, 1865, p. 19 (locust districts, from Fitch).

RILEY: 1st Rept. Ins. Mo., 1869, pp. 18–42, figs. 6–13; 4th Rept. do., 1872, pp. 30–34.

LE BARON: 2d Rept. Ins. Ill., 1872, pp. 124–133.

PACKARD: 3d Ann. Rept. Ins. Mass., 1873, pp. 16–20, figs. 142, 143.

BESSEY: in Amer. Entomol., iii, 1880, pp. 27–30 (distrib. in Iowa).

SAUNDERS: Ins. Inj. Fruits, 1883, pp. 35–39, figs. 24–27.

The Cicada in Western New York.

Examples of the above-named insect, together with peach-twigs showing its work, and empty pupal cases attached, were received at this department, about the last of June, 1882, from Ontario county, New York, with the inquiry if they were the true seventeen-year locust, and if so, if their appearance only at such long intervals could be accepted as a scientific fact.

FIG. 43—The seventeen-year Cicada—CICADA SEPTENDECIM: *a*, the pupa; *b*, the pupa case; *c*, the mature insect.

Fig. 43 shows the insect with its wings spread upon one side, the pupa from which it is disclosed, and the pupal case.

Seventeen Years Required for its Transformations.

Notwithstanding all that has been written of this species, and the labor that has been expended upon its study, it is a matter of surprise that there should still prevail a wide-spread incredulity that the period

stated is really required for the development of the insect from the egg into the perfect winged state. Yet it is a fact well established in science, and must therefore be admitted, although among the three hundred and fifty thousand species of insects known to us, no other has been found to require so long a period for its changes.

The Insect Seen Almost Annually.

It is sometimes urged by those who are unable to appreciate the authoritativeness of a scientific statement, that we hear of the appearance of these locust visitations at much shorter intervals — in some parts of the United States almost every year.

This is true. To go no further back in our records than to the year 1850 — from that time to the present the periodial Cicada (it is improperly called a *locust*) has made its appearance in portions of the United States, in each subsequent year to the present included, with the single exception of the year 1873. It will continue to appear during each subsequent year of the century, with three exceptions — 1887, 1890 and 1892, which in the chronology of visitations, happen not to be "locust years."

Why Reported so Frequently.

The explanation of these almost annual appearances of the species is very simple, and as follows: There are a number of distinct "broods" within the United States, each embraced within certain geographical localities and limits (although often overlapping one another) in which they appear, and within which they are always true to their appointed time.

As the limits of these broods do not vary to any considerable extent in their successive returns, it follows that they do not cover the entire country, but that there are portions in which they are never seen.

A Thirteen-year Brood.

Not all of these broods, however, are confined to a seventeen-year cycle. The researches of Professor Riley have shown that in the Southern States, and extending as far northward as southern Illinois, there are also broods that occur regularly at intervals of *thirteen years*, to which he has given the name of *Cicada tredecim*. No specific difference, however, can be discovered in the features of the two broods, and he has, therefore, expressed his opinion that the latter is not entitled to be regarded as a distinct species, but that it should rather be considered as a race, or as an incipient species, to which for convenience it is desirable to give a distinctive name (*Supplement to the Missouri Reports*, 1881, p. 58).

Number of Broods in the United States.

Dr. Fitch, in his *First Annual Report on the Insects of New York*, recorded nine broods in different parts of the United States. Prof. Riley, as the result of a more thorough and extended search of old records, gives, in his *First Report on the Insects of Missouri*, twenty-two broods, one of which he has subsequently rejected, from its failure to appear at its expected time and place, and the doubtful evidence upon which its former appearance (in 1870) rested. Of these twenty-one broods, seven are of the thirteen-year race.

Broods in the State of New York.

Of the above, five occur within the State of New York, viz.:

1. Commencing with the one, the appearance of which in Ontario county in June of 1882, as has been stated; former appearances are recorded in 1797, 1814, 1831, 1848 and 1865. Its next return will be in 1899. Its probable distribution is in portions of Wyoming, Monroe, Livingston, Ontario, Yates, Seneca, Cayuga and Onondaga counties.

2. To appear in 1885, in Brooklyn and the western part of Long Island, in the vicinity of Rochester, N. Y., and probably to a lesser extent in intermediate portions of the State.*

The range of this brood is stated to be from South-Eastern Massachusetts (across Rhode Island and Connecticut) to Long Island, New Jersey, Pennsylvania, extending up into Western New York, southward into Maryland, Virginia, West Virginia, Ohio, Michigan, Indiana and Kentucky. Its former records are, 1715, 1732, 1749, 1766, 1783, 1800, 1817, 1834, 1851 and 1868. The next appearance will be in 1902.

3. A brood to appear in 1889, on Long Island. Former visits have been in 1838, 1855 and 1872. It will also return in the year 1906.

This is of very extensive range, commencing in Massachusetts and crossing Long Island, is continued in New Jersey, South-Eastern Pennsylvania, Delaware, Maryland, Virginia, West Virginia, down the Ohio river and "the valley of the Mississippi river, probably to its mouth, and up its tributaries into the Indian Territory."

4. A brood in 1894, in the valley of the Hudson river. Dr. Fitch gives its northern extension as in the vicinity of Fort Miller, near to where the river has its westward trend. It extends southward along the river to its mouth, embracing, in its lateral extensions, New Haven, in Connecticut, Northern New Jersey and North-Eastern Pennsylvania.

*In the *New York Sunday Press* of June 20, 1885, the following notice appears: "Locusts have made their appearance by millions, in the middle of Long Island and on Staten Island. In Prospect Park, Brooklyn, the nuisance is said to be intolerable. In many places the insects cover the roadway and are crushed under wheels in countless numbers."

What is apparently the same brood seems also to extend into Maryland, Virginia and North Carolina; also into Michigan and Indiana, or perhaps, these last may be a coincident brood.

The records of this, date back to over a century and a half, viz.: to 1724, in New Haven, Conn. Subsequent returns were in 1741, 1758, 1775, 1792, 1809, 1826, 1843, 1860 and 1877. In the last recorded year they were very abundant in the vicinity of Albany. Large numbers of these were found to be infested with a fungus, which was described and named by the State Botanist, Prof. Charles H. Peck, as *Massospora cicadina.*

5. A brood in 1900 in Western New York. Former years of its appearance were 1832, 1849, 1866 and 1883. Its range is apparently not very extensive, as it seems to be limited to Western New York, Western Pennsylvania and Eastern Ohio. It is Dr. Fitch's 2d brood; Riley's No. xx. Miss M. H. Morris, of Germantown, Pa., to whom we are indebted for many valuable observations upon this insect, has recorded it as occurring in the year 1849 "in the northern portion of New York, from Buffalo through the entire length of Genesee county" (*Proc. Bost. Soc. Nat. Hist.*, iv, 1851, p. 110). This would give it a distribution at that time centrally through Erie, Wyoming and Genesee counties, with probable occurrence in Niagara, Orleans and Monroe counties. Since that time its range seems to have become more restricted and its numbers reduced. Our only knowledge of its appearance in 1883 is from an item in the *New York Herald* of about July 10th, that a "swarm of locusts," doing much damage, had appeared in Chautauqua county, the extreme south-western corner of the State.

In a former publication, I included with the above, a sixth New York brood — the xviiith of Prof. Riley — of which he predicted the return in 1881, of a few in Westchester county, based upon the observation by Mr. James Angus, of "straggling specimens" in Westchester county in 1864. But, as Mr. Angus informs me that in that year he "saw a few odd ones only, not more than two or three, although hunting pretty closely," and that in 1881, none were seen by him, it would obviously be improper to cite the above very limited appearance as a New York brood.*

In the above statement of years of appearance and range of distribu-

[*Its return was, however, noticed by Mr. W. T. Davis, upon Staten Island, N. Y, who reports, in *Entomologica Americana*, i, 1885, p. 92: "On May 8, 1881, while collecting insects with Mr. Leng in the neighborhood of Watchogue, Stat. Isl., we found a red-eyed Cicada pupa under a stone, and on June 5, eight specimens were collected, all of them males, and many of them being wet, having recently emerged. By the 12th of June they had become quite numerous, and I noted at the time that about one tree, I counted fifty-two pupa skins of the red-eyed Cicada."]

tion, we have drawn almost entirely upon the valuable compilation of the Cicada broods occurring in the United States given by Prof. Riley in his First Missouri Report, a work based upon so careful and extensive research among published records as to have left room for but little subsequent correction or addition.

The 1865–1882 Brood in New York.

There was not the opportunity of ascertaining from personal observation the range of this brood and the extent of its ravages in the summer of 1882, in Central and Western New York, and, subsequently, efforts to obtain information upon these points have met with hardly any success. The counties in which it probably occurs are given upon page 170. Its greatest abundance seems to have been in the vicinity of Canandaigua lake. In the *Ontario County Times* of June 28th, we find the following:

The fruit growers of Vine Valley [Yates county], on the east side of Canandaigua lake, are seriously disturbed by the recent appearance in that locality of countless millions of "seventeen-year locusts." They have come in such immense numbers as to cause widespread anxiety. Our informant, who visited the infested district on Monday, reports that the peach orchards and vineyards are suffering much from the ravages of the locusts, and says the noise made by their movements is so great that the human voice is almost drowned by it. They are feeding upon the tender foliage of the trees and vines, and fears are entertained that the growing fruit will be destroyed. The locusts have also appeared on the west shore of the lake [in Ontario county], and are reported to be doing considerable damage in peach and apple orchards.

Mr. N. J. Milliken, editor of the *Ontario County Times*, communicates the information that the locusts were particularly destructive in the Middlesex valley, on the east shore of Canandaigua lake, Yates county. They occurred in the Lake Keuka region, but no great amount of harm was done by them. In the town of Terry, of the same county the injury committed was comparatively slight, although "the noise made by them was equal to the united drum-corps of a mighty army."

In the last-named town, according to a note communicated by Prof. Riley, the area occupied was about four square miles, and somewhat less in the town of Middlesex.

Mr. Thomas J. Powell, of Naples, N. Y., has informed me that on the 28th of June, of 1882, he was in Victor, Ontario county, and went north four or five miles and found the locusts very abundant in the trees, making a continual humming. So far as he could learn they had caused but little damage.

Time of Appearance.

The time of the appearance of the insect would, of course, vary with the latitude, the southern ones being several weeks earlier than the extreme northern. In general terms, it may be stated as in the latter part of May. Dr. Harris states that "in Alabama, they leave the ground in February and March; in Maryland and Pennsylvania in May, but in Massachusetts they do not come forth until the middle of June."

In the extensive brood of 1868, which reached from the Atlantic to west of the Mississippi river, individuals were first noticed in Maryland and Pennsylvania from the 20th to the 25th of May; in Illinois on the 19th of May, and at St. Louis, Missouri, on the 22d of the same month. They usually continue for from five to six weeks, although straggling specimens may sometimes be seen for weeks later.

Life-History.

For detailed description of the egg, larva, pupa and perfect insect the First Report of Dr. Fitch may be consulted, and for the natural history, the excellent volume of Dr. Harris. It may suffice for this present notice, to state that the female selects a small branch of an apple-tree, oak or some other hard wood, near its tip, into which to place her eggs, always taking a position with her head directed toward the trunk. With her ovipositor shown at *b*, in Fig. 44, she saws little slits in the twig, making an oblique hole to the pith, and enlarging it into a fissure with splintered outward edges, as represented in Fig. 45. In each of these she places from ten to twenty eggs, in pairs side by side, but separated from each other by portions of woody fibre, and inserted somewhat obliquely so that their ends point upward. About fifteen minutes are required to make a fissure and fill it with eggs. Moving backward toward the tip of the branch another and others are made in line — sometimes to the number of fifty, if the twig be favorable for the purpose, by the same insect. Her complement of eggs is from four to five hundred. The female, exhausted by her labor, soon thereafter drops from the tree and dies.

FIG. 44. — CICADA SEPTENDECIM, showing at *a*, the beak; at *b*, the ovipositor.

FIG. 45. — Twig punctured by the Cicada.

The time required for the hatching of the eggs has been variously stated at fifty-two days, forty-two days, and even so low as fourteen days.

The newly-hatched Cicadas — about the one-sixteenth of an inch long, and shown in Fig. 46 — are slender, grub-like creatures, lively

as ants, but after running about upon the tree for a short time, they gather up their limbs and drop to the ground. Here they at once bury themselves, by the aid of their strong fore feet, which are admirably fitted for the purpose, and work their way, until they can attach themselves to the tender and succulent rootlets, into which they insert their beak, and find abundant nourishment in the sap. Ordinarily they bury at a moderate depth below the surface, where they remain until their advanced growth compels them, when in excessive numbers, to descend deeper in search of an ample food-supply.

FIG. 46.— Newly-hatched larva of CICADA SEPTENDECIM.

During the years of larval growth, but little alteration takes place in their appearance, beyond an increase of size, except the gradual development and enlargement of the four scales upon the back and sides that are to contain the wings in the pupal stage.

When near maturity, the larvæ gradually ascend toward the surface through circuitous galleries of about five-eighths of an inch in diameter, the walls of which are firmly compacted, and according to a statement, cemented and varnished so as to be water-proof. The upper portion alone of these burrows, to the extent of six or eight inches, is empty. The larva remains herein during its pupal state, and until the time for its final transformation. When this has fully come, the pupa, shown at *a*, in Fig. 47, burrows upward through the ground during the night, ascends the branch of a tree or some other convenient object, to which it fastens itself securely by its claws. Remaining in this position for awhile, and until the full time for its change is at hand, the pupal case parts in front and upon the back, the Cicada emerges through the fissure, crawls upward a little distance, leaving the empty case tightly fastened to the trunk as at *b*, the wings

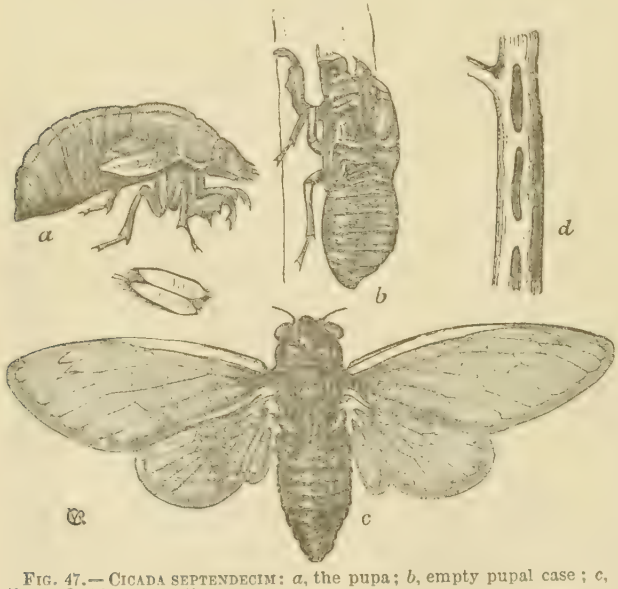

FIG. 47.— CICADA SEPTENDECIM: *a*, the pupa; *b*, empty pupal case; *c*, the perfect insect; *e*, the eggs.

expand, all the organs have become fully developed, and the insect has attained its perfect stage, as shown at *c*. If food is needed, it punctures the twigs with its beak, shown at *a*, in Fig. 44, and feeds upon the sap. After two or three weeks of a merry life, if we may judge from the almost ceaseless music with which the days are made vocal, the important work of oviposition is commenced and soon completed. Another month, and the brood, of so many years' gradual development, has become extinct.

Its Music and Musical Apparatus.

Dr. Fitch has referred to "the discordant din of the Cicada's shrill song." In endeavoring to convey an idea of the peculiar note, he says — "it is repeated at short intervals, and may be represented by the letters *tsh-e-e-E-E-E-E-e-e-ou*, uttered continuously, and prolonged to a quarter or a half minute in length, the middle of the note being deafeningly shrill, loud and piercing to the ear, and its termination gradually lowered till the sound expires" (1*st Rept. Ins. New York*, p. 42).

They appear to be capable of producing different sounds, for Prof. Riley states that "when disturbed the noise they make mimics a nest of young snakes or young birds under similar circumstances — a sort of a scream. They can also produce a chirp somewhat like that of a cricket" (1*st Rep. Ins. Mo.*, p. 24).

Dr. Burnett has made the musical apparatus of the Cicada the subject of careful study. He found it to be wholly integumental in its nature, and not presenting any relation either by structure or analogy to the respiratory system. The drum is situated in each side between the thorax and abdomen, having its head, which is of the size of a marrowfat pea, just under the point where the wings are attached to the body. It is a tense, dry, crisp membrane, crossed by cords or bars, produced by a thickening of the membrane, which meet on one side at the point of attachment of the muscles, which, by their contraction, keep it stretched. The sound is produced by a series of rapid undulations, running from the contracting muscles across the drum. The upper part of the abdomen serves as a sounding board, for with a portion removed, the sound is diminished in volume. A dry condition seems to be essential to the perfect action of the drum, as when it is moistened, or on wet days, the sound is very much diminished. The drumming is heard for four or five hours during the heat of the day, principally between the hours of twelve and two. In the female, there is no drum, nor any trace of the muscular apparatus belonging to it (*Proc. Bost. Soc. Nat. Hist.*, iv, 1851, p. 72).

Trees Attacked.

Dr. Harris mentions the oak as being their favorite tree in Massachusetts, and that they may be seen in oak forests in the middle of June in such immense numbers that they bend and even break down the limbs of the trees by their weight. Of fruit trees they prefer the apple. Above fifteen hundred Cicadas have been found to have emerged from the ground beneath a single apple-tree, leaving the surface of the ground "as full of holes as a honey-comb." Other recorded food-plants are locust, peach, pear, *Eupatorium*, hickory, chestnut, hazelnut, willow, poplar, cottonwood, white cedar or arbor-vitæ (*Thuja occidentalis*), red cedar (*Juniperus Virginiana*), and hemlock-spruce (*Abies Canadensis*)

The Cicada is not entirely dependent upon the roots of trees for its food. Although confined to timber lands, and not occurring in treeless regions or in those that have been under cultivation for seventeen years, yet in an instance recorded in Michigan, where the timber had been cleared for sixteen years and cultivated for most of that time, the Cicadas came out of the ground the seventeenth year in the treeless fields quite as numerously as among the timber. They appeared upon the same day with the others, were as large, and to all appearance, equally well-nourished, although for nearly their entire period, they must have subsisted upon the roots of grasses and herbs.

Some of the facts connected with their appearance under strange conditions would indicate that their food-habits are yet far from being wholly understood. In the instance recorded where they came up through the ground floor of a cellar which had been dug to the depth of five feet, it would be difficult to name the food — in kind and amount — that could have supplied the requirements of the voracious larvæ when approaching their maturity.

Injuries to Vegetation.

The injuries to trees are the result of the countless punctures made in the twigs for the deposit of the eggs. The twigs shrivel and die soon after the hatching of the eggs, and eventually are broken off by the winds, and fall to the ground, which is often covered by the dead material. A writer mentions the appearance of the forests in Pennsylvania and Ohio for the distance of a hundred miles, just after the locusts had left them — looking as if they had been scorched by a fire driving through them.

In the town of New Scotland, Albany county, N. Y., the Hudson river valley brood was so abundant in the year 1826, that "they destroyed the fruitage of the orchards almost completely. Nearly all the

tender branches of the trees were so wounded in the deposit of the eggs that they broke from the main stems in the following year and fell to the ground, thus completely denuding the trees of their fruit-bearing branches" (Wm. G. Wayne, of Seneca Falls, N. Y., *in lit.*).

These injuries to fruit trees are often quite serious, especially when they are young. Almost every tree in young orchards has been known to have been killed by them. Peach and pear trees suffer severely from the punctures, and grapevines have also been badly injured.

The peach twigs sent from Canandaigua, in 1882, show unmistakably the severity of the attack. Pupa-cases were adhering to them, for the number emerging from the ground compelled their distribution not only over the trunk and principal branches but even their extreme tips before they could find the necessary space to attach themselves for their transformation. The fissures made in oviposition were very close — in some instances running into one another as a continuous slit for the extent of two and three inches. One piece of twig, but twelve inches in length, contained fifty-three of the fissures.

The punctures made by the insect with its beak, for food, also contributes to the death of the twigs. The female only is chargeable with this injury, as her longer life and the development of her eggs renders food essential to her. She has accordingly been provided with a complete digestive apparatus, while her consort, destined to live for but a few days, shows scarcely a trace of a digestive canal (Burnett, *Proc. Bost. Society Nat. Hist.*, iv, 1851, p. 71).

Natural Enemies and Checks.

When we recall the immense numbers in which these broods at times present themselves in their extension over hundreds of miles of territory, bending the branches beneath the weight of a half dozen or more individuals upon each leaf (Burnett, *loc. cit.*, p. 72), and endeavor to form some conception of the fearfully augmented successive broods that would result from an unchecked multiplication, we cannot but feel a profound gratitude for the beneficent operation of the conservative forces in nature, that effectually prevent such an undue increase. Of the five hundred eggs borne by each female, as a rule but two eggs only complete their cycle and develop into the perfect insect, to maintain the number of the preceding brood. Fortunate it is that the insects are exposed to so many casualties and to destruction from so many enemies. Dr. Harris remarks:

Their eggs are eaten by birds; the young, when they first issue from the shell, are preyed upon by ants, which mount the trees to feed upon

them, or destroy them when they are about to enter the ground. Blackbirds eat them when turned up by the plow in fields, and hogs are excessively fond of them, and, when suffered to go at large in the woods, root them up and devour immense numbers just before the arrival of the period of their final transformation, when they are lodged immediately under the surface of the ground. It is stated that many perish in the egg state, by the rapid growth of the bark and wood, which closes the perforations and buries the eggs before they have hatched,* and many, without doubt, are killed by their perilous descent from the trees.

Other insects also prey upon them. Dragon-flies (*Libellulidæ*) have been seen to seize and devour them when they have just emerged from their pupal state, and are still tender and helpless. The larvæ of some species of fly, probably of the *Tachinidæ*, are known to feed upon them internally.

It is a fortunate circumstance in the economy of this insect, that so large a number of forest trees serve the purpose of oviposition equally well with our fruit trees; were it otherwise, its attack would invariably prove fatal to most of the young apple, pear and peach stock lying within its range.

Preventives of Injuries.

No method is known by which these attacks may be prevented, and very little can be done to mitigate them, when made by such innumerable hordes as are often witnessed. Something may be accomplished by beating them or by picking them by hand from young trees in the early morning and toward evening when they hang inactively upon the twigs, and it would be practicable, by the aid of a strong wind blowing in the right direction, to drive them with poles from the trees, compelling them to take wing and to seek the foliage of neighboring forest-trees. Without the wind, they would probably, after a short erratic flight, again return to the trees or transfer themselves to an adjoining orchard.

Destroyed by a Fungus.

As the attack of the fungus, *Massospora cicadinæ*, referred to on page 171, was observed by Prof. Peck to be of economic importance in preventing the propagation of the species, his remarks thereupon are

* This sometimes occurs in thrifty young apple-trees, and in twigs of considerable size, usually as large as a man's finger, where the injury caused by the deposit of the eggs has not been sufficient to check, materially, the growth of the branch. In such cases the twigs grow so rapidly, that in the course of the month which intervenes between the time of the laying and the hatching of the eggs, the wound heals completely over, the tent of splinters is nearly or quite overgrown, and the young insects never emerge from the eggs, being inclosed in a living sepulcher (Le Baron, *Second Report on the Insects of Illinois*, 1872, pp. 126–7).

herewith given, extracted from the 31st Report on the *N. Y. State Museum of Natural History*, 1879, pp. 19, 20:

It is a well-known fact that various insects are subject to the attack of parasitic fungi which prove fatal to them. The common house-fly is destroyed by one [*Entomophthora muscæ*], the silk-worm by another [*Botrytis Bassiana*], and the pupæ of different moths by others.

Another noticeable instance of this kind was observed the past season. It was found that the "seventeen-year locust," *Cicada septendecim*, which made its appearance in the Hudson river valley early in the summer, was affected by a fungus. The first specimen of this kind that I saw was taken in New Jersey, and sent to me by Rev. R. B. Post. Examination revealed the fact that the Cicadas or "seventeen-year locusts," in this vicinity, were also affected by it. The fungus develops itself in the abdomen of the insect, and consists almost wholly of a mass of pale yellowish or clay-colored spores which, to the naked eye, has the appearance of a lump of whitish clay. The insects attacked by it become sluggish and averse to flight, so that they can easily be taken by hand. After a time some of the posterior rings of the abdomen fall away, revealing the fungus within. Strange as it may seem, the insect may, and sometimes does, live for a time even in this condition. Though it is not killed at once, it is manifestly incapacitated for propagation, and, therefore, the fungus may be said to prevent, to some extent, the injury that would otherwise be done to the trees in the deposition of their eggs. For the same reason, the insects of the next generation must be less numerous than they would otherwise be so that the fungus may be regarded as a beneficial one. In Columbia county, the disease prevailed to a considerable extent. Along the line of the railroad between Catskill and Livingston stations many dead Cicadas were found, not a few of which were killed by the fungoid mass. As the insect makes its appearance only at intervals of seventeen years, and consequently will not be seen here again till 1894, it will scarcely be possible to make any further observations upon it for some time to come, yet it would be interesting to know how the fungus is propagated, or where its germs remain during the long interval between the appearance of the two generations. Do the fungus germs enter the ground in the body of the larvæ, and slowly develop with its growth, becoming mature when it is mature, or do they remain quiescent on or near the surface of the ground, waiting to enter the body of the pupa as it emerges seventeen years hence? Or, again, is it possible that the fungus is developed annually in some closely related species as the "harvest-fly," *Cicada canicularis*, and that it passes over from its usual habitat to the seventeen-year Cicada whenever it has the opportunity? These questions are merely suggestive; they cannot yet be answered.

Prof. Joseph Leidy had previously observed this fungus as early as in 1851 — see the *Proceedings of the Philadelphia Academy of Natural Sciences*, for 1851, v, p. 235 — but had not named it.

Chermes pinicorticis Fitch.

The Pine-bark Chermes.

(Ord. Hemiptera: Subord. Homoptera: Fam. Aphididæ.)

Coccus pinicorticis Fitch: in Trans. N. Y. St. Agricul. Soc. for 1854, xiv, 1855, pp. 871–873; 1st Rept. Ins. N. Y., 1856, pp. 167–169 (description of wingless form).

Chermes pinifoliæ Fitch: in Trans. N. Y. St. Agricul. Soc. for 1857, xvii, 1858, p. 741; 4th Rept. Ins. N. Y., 1859, p. 55 (description of winged form).

Coccus pinicorticis. Walsh: in Pract. Entomol., i, 1866, p. 90 (the larvæ of *Aspidiotus pinifoliæ*).

Chermes pinicorticis. Shimer: in Trans. Amer. Ent. Soc., ii, 1869, pp. 383–385 (winged form bred from the wingless).

Coccus pinicorticis. Lintner. in Count. Gent. for Aug. 21, 1873, xxxviii, p. 535.

Coccus pinicorticis. Glover: in Rept. Commis. Agricul. for 1876, p. 44 (mention).

Chermes pinifoliæ. Thomas. 8th Rept. Ins. Ill., 1879, p. 156 (from Fitch).

Chermes pinicorticis. Osborn in Trans. Iowa St. Horticul. Soc. for 1878, xiii, p 400 (habits, etc., without name), id., for 1879, xiv, pp. 96–107 (diff. stages); Bull. Iowa Agricul. Col., 1884, pp. 97–105 (general account).

Chermes pinifoliæ. Packard: Ins. Inj For.-Shade Trees, 1881, p. 118 (from Fitch).

The specific and common names of this insect indicate the tree upon which it occurs. Of the several varieties of pine, it is almost entirely confined to the Scotch pine (*Pinus sylvestris*) and the White pine (*Pinus strobus*). Its more usual habitat is upon the smooth bark around and below the axils where the limbs start from the trunk. Its appearance is that of little spots or patches of a white, flocculent, wool-like substance, adhering to the bark. This, however, is only a secretion, for the insect may be found beneath it when the covering matter is parted or brushed away.

The Secretion.

This white substance, which alone attracts the attention of the ordinary observer, as it completely hides the insect from view, is found, according to Dr. Shimer, most abundantly upon young white pines, near the ground in early spring, at about the time the frost is leaving the ground. Later it extends upward upon the trunk and into the axils of the branches. When examined with a magnifier, it has the appearance of "fine Saxony wool, the crinkled fibres drawing apart as do those of wool." Microscopic examination has shown it to be given out from some gland-like organs arranged in four rows upon the back and sides of the body of the insect.

Similar secretions are produced by many other of the *Aphididæ*. It occurs in the sub-family of *Aphidinæ*, in the beech aphis, *Phyllaphis fagi* (Linn.). In the *Pemphiginæ* we have many notable examples of it, as in the woolly aphis of the apple-tree, *Schizoneura lanigera* (Haus.); the woolly aphis of the elm, *S. ulmi* Thomas; the woolly aphis of the oak, *S. quercı* Fitch; the alder blight, *S. tessellata* Fitch, etc. It also pertains to many of the species of *Pemphigus*, and indeed, according to Prof. Riley, is a feature common to the entire sub-family of *Pemphiginæ*.

From its occurrence upon so many species nourished by so greatly differing food-plants, it is not strange that in appearance it should be compared with such different substances as cotton, wool, silk, wax and meal. Some of the material examined microscopically by Buckton was found to consist of long flattened threads or fibres, with obscure, transverse and longitudinal striations, and when broken to show strong fractures as if they were brittle. That it was not of a waxy nature appeared from its insolubility in alcohol and a solution of potash — its scorching over a lamp without melting, and evolving a nitrogenous odor like that of burned feathers.

Of some of the species of *Pemphigus*, Dr. Thomas asserts that they do secrete a waxy substance that will melt under the heat of the hand.

For remarks upon the secretions of some other Hemipterous insects, pages 284–5 of my first report may be referred to.

The Insect and its Changes.

Within this secreted material, appearing as little downy balls fastened to the twigs and branches, upon its being pulled apart early in the spring the wingless mother of the pine-bark Chermes, may be found, together with a number of her small yellowish, moderately ovate eggs — perhaps from twenty-five to fifty.

Early in April, in favorable seasons, the eggs commence to hatch. The young larvæ emerge from the ball and travel actively over the bark for a short time. They are so small as to be almost invisible to the naked eye, of an oval outline, flattened, of a light brown color, with short legs, three-jointed antennæ, a sucking-tube extended beneath their body, and a short hair on each side of the abdominal segments. The two left-hand figures show the larva as seen from above and from beneath.

In the fore part of May, the larvæ are more abundant than at any other time. Their traveling soon ceases, and they attach themselves by their beaks to the tender bark of the young twigs. As their feeding proceeds, they increase rapidly in size, assuming a dark reddish-brown

color approaching black, while the secretion from their bodies commences, and soon hides them entirely from sight.

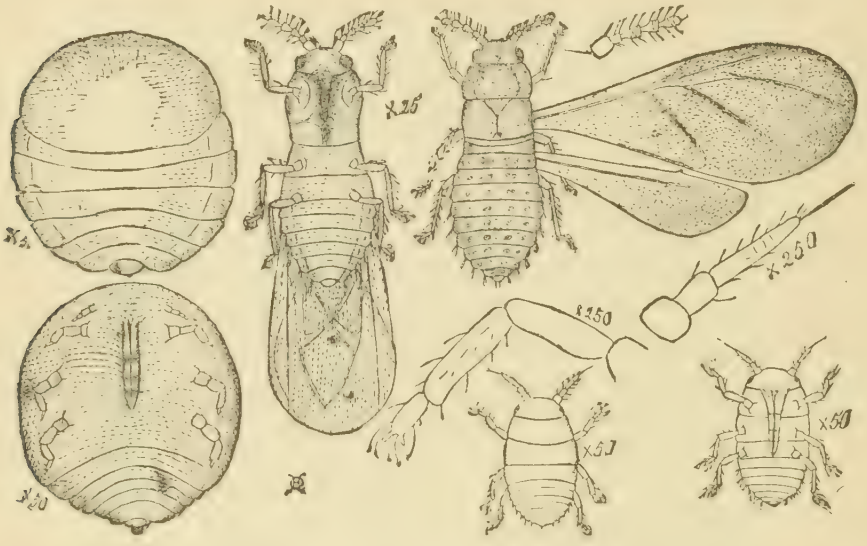

FIG. 48.— The Pine-leaf Chermes, CHERMES PINICORTICIS — the larva, the wingless female, and the winged form (male?).

The time required to attain the mature form has not been recorded, but the change probably occurs toward the last of May. The female destined to continue the species by laying eggs for another brood may be recognized by being without wings, of an oval form which becomes pyriform during egg-laying, with legs proportionally longer than in the larval stage (see the enlarged view), and three-jointed antennæ. The lower right-hand figures give upper and lower views of the female. From her oviposition, a second brood results, which is followed by others, at unknown intervals until some time into the autumn.

In one particular, the first brood differs from the later ones, in that it embraces a winged form. During the latter part of May, individuals are to be found showing the pupal stage, by being provided with wing-pads — otherwise they resemble the larvæ. The thorax is reddish, the abdomen of a darker red, the wing-pads yellowish, and a little of the woolly material adheres to portions of the body.

They continue in this stage but a few days, until about the first of June, when their outer encasement parts asunder, and the winged form issues, the appearance of which is shown in the figure. The antennæ of these are five-jointed, the body is almost black, and the four wings

are white, transparent, and folded roof-like over the body.* The sex of this form, or whether both sexes are embraced under it, seems not yet to have been determined. They have not been observed in copulation or in the deposit of eggs. There is abundant room for careful study in the life-history of this species, such as has been given to closely allied forms, in the admirable paper of Messrs. Riley and Monell, giving biological notes on the Pemphiginæ.†

The above natural history of the species is mainly from observations made upon it during the years 1878 and 1879, by Prof. Herbert Osborn, of the Iowa State Agricultural College, to whom also we are indebted for the figure used in illustration.

History.

An unfortunate mistake was made by Dr. Fitch in describing this insect, in his First and Fourth Reports (*loc. cit.*), as two distinct species. The single-jointed tarsus, the simple organization, and the waxy covering, led him to regard it as a *Coccus*, his first published observations upon it not having been continued long enough to show him its subsequent development into the winged stage. When in after years the winged individuals were met with, their Aphidian character was at once recognized and they were correctly referred to the genus *Chermes*, but without associating them with the wingless forms previously observed. And again in this stage, his usual careful habit of observation is not apparent, for although the life-history of "the first true Chermes that has been observed in this country," should have entitled it to careful study at his hands, the following statement is quite at variance with the later observations of others:

> The females [winged] do not extrude their eggs, but clinging closely to the leaf with their heads toward its base, they die, their distended abdomens appearing like a little bag filled with eggs. The outer skin of the abdomen soon perishes and disappears, leaving the mass of eggs adhering to the side of the leaf, but completely covered over and protected by the closed wings of the dead fly.‡

* Prof. Osborn, who has apparently made a careful study of the venation of this insect, states that "the posterior wings have a subcostal vein with *no branch veins*." A different statement was made by Dr. Fitch in that the longitudinal rib-vein of the hind wings "sends off, forward of its middle, a branch almost transversely inward, its tip curved backward." Dr. Shimer corroborates Dr. Fitch, in stating from his examination of living specimens that "the posterior wing has only a rib vein which forks opposite the quite conspicuous hook."

† *Bulletin of the U. S. Geological and Geographical Survey of the Territories*, v, 1879, pp. 1–17.

‡ See above, from the observations of Prof. Osborn, the occurrence of *wingless* females with their extruded eggs [and pyriform body during egg-laying], within little downy balls fastened to the bark. Of *Chermes laricis*, of Europe, it is stated that as the apterous female slowly deposits her eggs, she partly covers them with the down that she strips from her body, and that they are piled around and upon her until she is nearly half buried in the mass.

A strange blunder was made by Mr. Walsh in regarding the species as identical with the pine-leaf scale insect (*Chionaspis pinifoliæ*). He wrote as follows to a correspondent: "The insects infesting the white pine do not belong to the Aphis family (plant-lice), but to the Coccus family (bark-lice). The elongate white scale on the leaf was described by Fitch as *Aspidiotus pinifoliæ;* the downy patches on the bark as *Coccus pinicorticis.* But I believe that they are the same species, the former containing the eggs, like the scale of the common bark-louse of the apple-tree, and the latter being the young larvæ with downy matter exuding from them."

In 1869, Dr. Shimer published the results of his study upon this insect, called by him the "white-pine louse," made by him during the preceding year. From specimens of *Coccus pinicorticis* Fitch, inclosed in a feeding cage on June 3, the following day he obtained *Chermes pinifoliæ* of Fitch (the winged form), thus clearly establishing their identity.

Four years later, forgetting the above article of Dr. Shimer, and following the lead of Dr. Fitch, I committed the error of referring to this species as *Coccus pinicorticis*, in a notice of it contributed to the *Country Gentleman* (see citation).

Other Species of Chermes.

The species of this genus are not numerous. From this, in part, but mainly for the reason, it may be supposed, that their oviporous reproduction limits their increase and consequent destructiveness much below that of others of the family which multiply with such fearful rapidity through the simple process of gemmation — they have failed to receive the study bestowed upon their near relatives, the *Aphidinæ* and the *Pemphiginæ.*

Two other pine-feeding species of *Chermes* occur in Europe, which have not yet been detected in this country, viz., *Chermes pini* Koch, and *Chermes corticalis* Kaltenbach.

Another species has been discovered by Dr. Fitch, in Washington county, New York, extracting the juices from the leaves of the larch, *Larix Americana.* It was briefly characterized, mainly from wing features, in the *Transactions of the N. Y. State Agricultural Society*, for 1857, p. 753, and also appearing in the 4th *Annual Report on the Insects of New York*, p. 66 (3d-5th Reports, 1859), as *Chermes laricifoliæ.*

Dr. Packard in his *Guide to the Study of Insects*, 1869, p. 522–3, figures a pupal and a winged form resembling European species of *Adelges* Vallot (*A. coccineus* of Ratzburg and *A. strobilobius* of Kaltenbach), found by him in abundance, upon spruces in Maine, and producing

swellings at the ends of the twigs, resembling in size and form the cones of the same tree. Dr. Thomas, in his 8th *Report on the Insects of Illinois*, 1879, pp. 156–7 has given to this form the provisional name of *Chermes abieticolens*. The figure of Dr. Packard is introduced here in illustration of the genus.

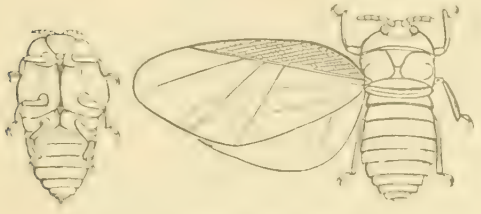

FIG. 49.— CHERMES ABIETICOLENS Thomas.

In *Insects Injurious to Forest and Shade Trees*, 1881, p. 234, Dr. Packard, reproduces his remarks and figures from *Guide*, etc., upon "*Adelges abieticolens* Thomas." He also records (p. 235) his observation of "*Adelges abietis* Linn." (*Chermes abietis*) of Europe in considerable numbers upon Norway spruces, in Salem, Mass.

A species quite injurious to the larch in Europe is *Chermes laricis* Hartig.

Another species depredating upon spruces in Europe has been described by Kaltenbach as *Chermes strobilobius*.

It is worthy of note that all of the above-named species — eight in number — are confined to coniferous trees. A single species only, so far as known to me, is found upon other vegetation, viz., the *Chermes atratus* of Buckton, occurring upon oak (*Quercus*).

Injuries of the Insect.

A tree badly infested with this insect becomes sickly and presents a slender, dwindled appearance; its leaves are short and stinted in their growth, and of a dull green color, and the annual growth of the tree is much curtailed (Fitch).

Its attack seems usually to be made upon trees that have been transplanted for the ornamentation of grounds, and is rarely observed upon those that are growing under their native condition.

According to Prof. Osborn, the Scotch pines in Ames, Iowa, and on the college grounds, were seriously infested for successive years.

At Fort Dodge, Iowa, the insect was reported as extremely abundant, and was observed literally piled up in the new growth.

Quite a severe attack was brought to my notice a few years since, through a communication from Tivoli, Dutchess county, N. Y., to this effect:

I inclose to your address a portion of a pine limb covered with a white substance, with the desire that you give me your opinion of what it is, and what I can do to remove it. The trees are large pines in the avenue, and are looking very badly — in fact, are slowly dying. It does

not affect all the trees, and those that are free from it are vigorous and healthy, which leads me to the opinion that this white substance is the cause.

The piece of limb sent was ten inches in length, nearly two inches in diameter, and was almost entirely covered with the insect and its flocculent mantle, some of the fibres of which were a quarter of an inch long. When received, August 7th, large numbers of the young, of almost an orange color and of an elongate form, were associated with the dark brown adults, showing that the attack of which complaint was made, was being actively and persistently continued.

Natural Enemies.

The multiplication of this insect is checked by quite a number of natural enemies that are known to prey upon it, and to be very active in its destruction.

Five species of lady-birds (*Coccinellidæ*) have been seen feeding upon it, viz., the Painted lady-bird, *Harmonia picta* Rand., Fig. 50; the Twice-stabbed lady-bird, *Chilocorus bivulnerus* Muls., Fig. 51; *Pentilia misella* Le Conte; *Scymnus terminatus* Say, and another *Scymnus* larva, differing from *S. terminatus*, but not reared to its perfect stage.

Fig. 50.—The Painted lady-bird, HARMONIA PICTA: *a*, the larva, enlarged; *b*, the beetle natural size; *c*, the same enlarged.

Fig. 51.—The Twice-stabbed lady-bird, CHILOCORUS BIVULNERUS, the larva and imago.

A larva of a lace-winged fly, *Chrysopa* species, that covered its back with the woolly material stripped from its victims, was observed by Dr. Shimer; also the larvæ of unknown species of Syrphus flies. These larvæ are known to render most excellent service in the destruction of plant-lice. Fig. 52 represents the larva of *Chrysopa*, and Fig. 53 that of a Syrphus fly in the act of devouring an *Aphis*.

Fig. 52.—Larva of a lace-winged fly, CHRYSOPA, sp.

Fig. 53.—Larva of a Syrphus fly.

The larva of a Heteropterous insect, resembling a small ant, was seen running actively about the infested pines, seizing and sucking the juices of the insects. It was determined by Mr. Uhler as *Camaronotus fraternus*.*

Prof. Osborn discovered some round, black, hard and shiny mites within the downy balls of the *Chermes* which were believed to be feeding upon them. They evidently belonged to the genus *Oribates*.

* The resemblance of the European *Camaronotus cinnamopterus* Kirsch., to the large wood ant, *Formica rufa*, has been noted.

Remedies.

When the insect is found upon young trees the bark of which has not become very rough, or when confined to the smoother bark of the branches and twigs, most of them can be easily killed by going over the bark and crushing them by the vigorous use of a stiff bristle brush. In connection with the brush a strip of cloth could be advantageously used by applying it to the axils of the branches and drawing it repeatedly backward and forward through them; or with a single turn around a branch, moving it gradually outward upon the limb with the same sawing motion.

Where larger trees and more extended surfaces are infested, a solution of whale-oil soap — a quarter of a pound to a gallon of water — applied with a force pump, would destroy the insect. The stronger application of kerosene emulsions required for adult scale-insects, would not be needed for this Aphid, for its flocculent covering instead of serving as a protection to it only aids the efficacy of the applied insecticide in absorbing and holding it until it may have its desired effect.

A method employed against the Larch Chermes of Europe, *Chermes laricis* Hartig, which seems also to serve as a preventive of subsequent attacks, is given by Miss Ormerod in her *Manual of Injurious Insects* (p. 194–5):

To thirty-six gallons of water add half a pound of perchloride of mercury; with this the infested trees are drenched in the early summer, when the sap is flowing freely; a dry day is preferred for the operation, as it gives time for the solution to soak thoroughly into the bark. This has been applied to ornamental trees and it is noted that trees operated on in 1873, continued, at the time of writing (1880), free from the "bug," and in thriving condition. This application requires to be in careful hands, being poisonous. Woodpeckers that fed upon the poisoned insects were destroyed by it.

Chimarocephala viridifasciata (DeGeer).

The Green-striped Locust.

(Ord. ORTHOPTERA: Fam. ACRIDIDÆ.)

Acridium viridifasciatum DE GEER: Mem. Hist. Ins., iii, 1773, p. 498, pl. 42, f. 6; GOEZE: Gesch. Ins., iii, 1780, p. 325, pl. 42, f. 6.

Gryllus Virginianus FABR.: Syst. Ent., 1775, p. 291; Spec. Ins., i, 1781, p. 368; Ent. Syst., ii, 1793, p. 57.

Gryllus Locusta chrysomelas GMELIN: Linn., Syst. Nat. i, pt. iv, 1788, 2086.

Acridium Virginianum OLIVIER: in Encyc. Method., vi. 1791, p. 224.

Acridium marginatum OLIVIER: in Encyc. Method., vi., 1791, p. 229.

Acridium hemipterum PAL. DE BEAUVOIS: Ins. Afr.-Amer., 1805–21, p. 145, pl. 4, f. 3.

Œdipoda Virginiana BURMEISTER: Handb. d. Entomol., ii, 1838, p. 645.

Locusta (Tragocephala) viridi-fasciata HARRIS: Rept Ins. Mass., 1841, p. 147; Ins. N. Engl., 1852, pp. 158–9; Ins. Inj. Veg., 1862, p. 182, pl. 3, f. 2.

Locusta (Tragocephala) infuscata HARRIS: Rept. Ins. Mass., p. 147; Ins. N. Engl., 1852, p. 158; Ins. Inj. Veg., 1862, pp. 181–2.

Locusta (Tragocephala) radiata HARRIS: Rept. Ins. Mass., 1841, p. 148; Ins. N. Engl., 1852, p. 159; Ins. Inj. Veg., 1862, pp. 183–4.

Gomphocerus viridi-fasciata UHLER: in Harr. Ins. Inj. Veg 1862, p. 181; ib. as *Gomphocerus infuscatus* and *G. radiatus.*

Tragocephala viridi-fasciata. SCUDDER: in Bost. Journ. Nat. Hist., vii, 1862, p. 461; Cat. Orthop. N A.—Smithson. Miss. Coll, No. 189, 1868, p. 82; Entomolog. Notes, iv, 1875, pp. 80–82.

Tragocephala viridifasciata. GLOVER: Illus. N. A. Ent.—Orthop., 1872, pl. 5, f. 9.

Tragocephala viridifasciata. RILEY: 8th Rept. Ins. Mo., 1876, p. 149, f. 46.

Chimarocephala viridifasciata SCUDDER: in U. S. Geograph. Surv. West of 100th Mer., 1876, p. 508.

Tragocephala viridifasciata. THOMAS: 9th Rept. Ins. Ill., 1880, pp. 85, 93, 105–6, figs. 13, 17: Synop. Acrid. N. A. (in Hayden's Rept. U. S. Geolog. Surv. Terr., v, 1873), 1873, pp. 103–4, pl. f. 3; id., p. 102, as *T. unifasciata* Harr.

Tragocephala viridifasciata. LINTN.: in Count. Gent., Mch. 9, 1882, xlvii, p. 189 (winter appearance).

Chimarocephala viridifasciata. BRUNER: in 3d Rept. U. S. Ent. Commis., 1883, p. 56 (in list of N. American Acrididæ).

Midwinter Appearance of the Insect.

In several portions of the State of New York — at its eastern and western extremities, and at intermediate localities, much interest was excited, and in some cases considerable alarm, by the sudden appearance in the pastures and meadows at about the middle of February, 1882, of large numbers of this insect, hopping about in the warm sunshine, almost as actively as in the month of June.

My attention was called to them by a note received from Mr. G. M. Gillette, of Bergen, Genesee county, in which he wrote:

I to-day mail you what I should term grasshoppers if it were only later in the season. They are as plentiful as in the month of July. On the 14th of this month, they could be seen by the million sunning themselves on the south side of stone walls in this vicinity.

Examination showed them to be the young of the Green-striped locust, the *Locusta (Tragocephala) viridifasciata* of the Harris Reports. They measured from four-tenths to six-tenths of an inch in length — the smaller being in the larval stage, without indication of the wing-pads, and the larger in the pupal stage,

FIG. 54.—The Green-striped Locust, CHIMAROCEPHALA VIRIDIFASCIATA: *a*, larva; *b*, adult.

with wing-pads extending half the length of the abdomen. In Fig. 54, the larva is shown at *a*, and the full-grown and winged insect at *b*.

Upon addressing Mr. Gillette for further information concerning them, and proposing some observations desirable to be made, the following reply was received under date of February 28th.

Their Appearance in Genesee County.

The young grasshoppers were first seen as early as the 10th of February. No winged ones were observed, and I think it is safe to say that there were none. When first noticed, they were upon an old stone-wall, apparently sunning themselves.

On February 14th, having occasion to cross an old unused meadow, and also a ten-acre lot of fall-sown wheat, I found them in great numbers. They were very active, and it was no little effort to catch and cage those sent to you. There was no snow upon the fields at the time, but along the wall where there were patches of snow, they were as lively as upon the grass, and seemed rather to enjoy a good "hop, skip and jump" upon the smooth surface. There have been no birds in this vicinity [reply to question], consequently I do not think that they have been disturbed. They may have been attacked by snow-birds, although quite scarce, but not to my knowledge.

Later, upon the 1st of April, Mr. Gillette saw "a large flock of black-birds [probably the red-winged black-bird, *Agelæus Phœniceus*] feeding sumptuously upon the poor persecuted grasshoppers. The birds came in immense flocks." The grasshoppers had not up to that date increased perceptibly in number or in size. The nights had been cold, "but the 'hopper was early up waiting for the sun." Of a half-dozen specimens inclosed in a box February 15, without food, three were alive two weeks later. Upon the 22d of April, Mr. G. wrote: "I have yet one grasshopper alive of the original six. He has to-day completed his ninth week without a morsel of food, and although he seems to be failing, I hope to keep him another week and give him a good record."—"The sole survivor made his escape after a confinement of ten weeks and three days."

The grasshoppers continued to be seen at Bergen until April 9th after having been observed for nearly a month.

Their Appearance in Westchester County.

The Albany *Evening Journal*, of February 21st, contained the following notice:

The farmers in the vicinity of Mount Kisco, Westchester county, N. Y., are greatly troubled in mind concerning the appearance of a black grasshopper which was noticed two or three days ago in the fields. They were first discovered by George Sypher on the farm of Isaac Thorne. The young man was walking through the field, and he noticed

the insects skylarking on the beautiful snow. Having never seen such a sight in midwinter, Sypher was at first inclined to take to his heels and run for his life, fearing that something had got wrong in his head. But finding that he had full control of his senses, he began an investigation of the strange phenomenon, and when he had satisfied himself that there was no fiction about the grasshoppers, he caught half a dozen of them and introduced them to Mr. Thorne. The gentleman was also surprised, and immediately started for the field to carry on a more thorough investigation. There he found scores of the insects, skipping around in the sunshine, and after securing a bottle full, went among his neighbors exhibiting them. They were all greatly astonished at the hoppers' appearance, declaring that such an invasion was never heard of before in the winter in that region.

Since their appearance on Mr. Thorne's place, they have been reported in a number of localities in that vicinity. The farmers express alarm lest a new pest should make its appearance next summer, of which these hoppers are the advanced guard. The insects are jet black [?] and somewhat smaller than a cricket. Nothing like them was ever seen before at any time.

No Cause for the Alarm.

Other notices of the general character of the above appearing in several of the newspapers of the State, and my attention being called to them, — in a communication to the Albany *Evening Journal* of February 25th, I gave the assurance, that although these grasshoppers had appeared "by millions," yet the farmers need entertain no apprehension that their occurrence at this time indicated extensive depredations from them the ensuing season. It was not unusual for specimens of the species in moderate numbers to emerge from their winter retreats in stone-walls and elsewhere during a continuance of warm weather in winter. They had never been known as a particularly injurious species, as the red-legged grasshopper, *Caloptenus femur-rubrum*, at times, proves to be. Their appearance in immense numbers at this time should be regarded as a favorable omen, as promising diminished numbers during the summer months, for very many of those which had been prematurely aroused from their winter sleep would fall victims to the cold which sharply followed their awakening.

The Attendant Meteorological Conditions.

As will be more fully stated hereafter, it is the habit of this species to pass the winter in an inactive state, in the form of larvæ and pupæ, in sheltered places in old stone-walls, beneath roots of grasses, under piles of rubbish, etc. Under the ordinary temperature of the winter months, their quiet hibernation would not be disturbed, nor their winter's sleep broken until the warm days of early May aroused them from

their torpor, and summoned them to activity and to the food awaiting them in the already green fields. But at the time above stated for the premature awakening and coming forth of *C. viridifasciata*, we find from the records that unusually warm weather was prevailing. From an average temperature for the several preceding weeks of 27° Fahr., it suddenly changed to a mean temperature (of one week) of 40°, reaching at the highest 56°. The records of the U. S. A. Signal Service, at Albany, show the following temperatures for the months of January and February, of 1882:

January	1–7,	mean temp.,	23°.	Highest temp.,	41°.
"	8–14,	"	37°.	"	47°.
"	15–21,	"	30°.	"	48°.
"	22–28,	"	21°.	"	40°.
"	29–Feb. 4,	"	25°.	"	45°.
Feb.	5–11,	"	33°.	"	47°.
"	12–18,	"	**40°.**	"	**56°.**
"	19–25,	"	29°.	"	40°.
"	26–Mch. 4,	"	41°.	"	56°.

The month of February is recorded as "much the warmest February since the establishment of the Signal Station" at Albany, in 1873, the mean temperature of the 16th having been 50°. The December preceding had also been the warmest during the same period, having had a mean temperature of 39°, as against an average of 27° for the seven previous years.

Description of the Insect.

Dr. Harris gives the following description of the species: Green; thorax keeled above; wing-covers with a broad green stripe on the outer margin extending from the base beyond the middle and including two small dusky spots on the edge, the remainder dusky but semi-transparent at the end; wings transparent, very pale greenish yellow next to the body, with a large dusky cloud near the middle of the hind margin, and a black line on the front margin; antennæ, fore and middle legs reddish; hind thighs green, with two black spots in the furrow beneath; hind shanks blue-gray, with a broad whitish ring below the knees, and the spines whitish, tipped with black. Length about one inch; expanse from more than one inch and three-fourths to nearly two inches.

Dimorphic Forms.

The species, according to Mr. Scudder, is quite variable, but presents an interesting case of dimorphism, in that it appears under two distinct

forms. For the one, the form above described, he has retained the name under which it had been described by Fabricius, viz., *Virginiana* (see the Synonymy given), and for the other, *infuscata* — the name under which it had been described by Dr. Harris as a separate species. The two differ in the presence or the absence of bright green colors, which in the former replace the gray of the latter, in the whole of the head, the front part of the thorax (pronotum), the hind thighs, and on the greater portion of the costo-basal half of the fore-wings, and in spots beyond the middle of their front border. These differences appear to be mainly sexual, for in about one hundred and fifty examples examined by Mr. Scudder, 84 per cent of the males were *infuscata*, and 77 per cent of the females *Virginiana*.

Synonymy.

It will be seen from the table of synonymy given, that the species has been peculiarly unfortunate in the number of names that it has received both generic and specific — Dr. Harris having made three species of it.

The generic name under which it is herein included, was proposed for it by Mr. Scudder in consideration of *Tragocephala* being preoccupied in the Coleoptera.

Habits and Natural History.

As soon as the weather becomes sufficiently warm in the spring, these young grasshoppers come from their retreats and commence to feed. Many of them (the more advanced) have attained their maturity and acquired their wings by the middle of May. A few days after maturity the female deposits her eggs. By means of the horny appendages with which the tip of her abdomen is provided, she drills a hole in the ground the length of her abdomen, which she proceeds to fill with from twenty to thirty eggs arranged symmetrically in four rows, and forming, when the operation is completed, a pod-like mass, firmly cemented together by a mucous matter secreted with the deposit of each separate egg. Fig. 55 shows the oviposition of the Rocky Mountain locust, and as the methods are very similar in the *Acrididæ* it may illustrate that of

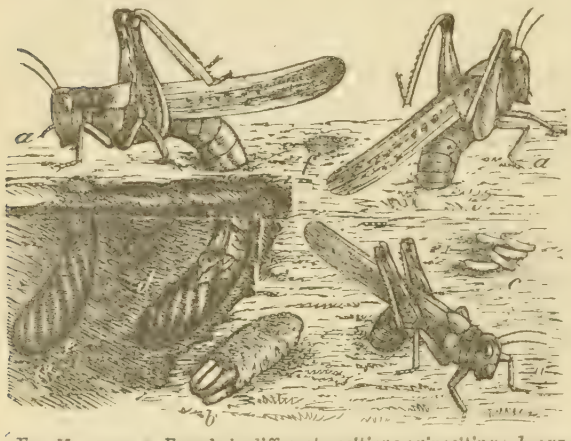

Fig. 55. — *a*, *a*, *a*. Female in different positions ovipositing; *b*, egg-pod extracted from the ground, with the end broken open; *c*, some separate eggs; *d*, *e*, a section showing an egg-pod placed and another being placed; *f*, where a pod has been covered up.

this species. Two or three weeks later, another deposit of eggs is made in the same manner, and a third, and perhaps a fourth, at intervals thereafter.* The eggs hatch in about three weeks, and produce the forms mentioned by Dr. Harris as occurring "in various states of maturity, in pastures and mowing lands, from the first of June to the middle of August," in the New England States.

After leaving the egg, the insect undergoes at intervals two moltings without showing the wing-pads that are later developed. These are known as the three larval stages. Another molt brings it to its first pupal stage, in which the small wing-pads are in position, turned upward over the back. The fourth molt develops the fifth stage, or the true pupa in which the wing-pads attain their greatest development and the thorax has assumed nearly the form of that of the mature insect. With the fifth molting the mature, winged insect appears. Fig. 56 represents the larvæ at different stages and the true pupa of the Rocky mountain locust.

FIG. 56.—CALOPTENUS SPRETUS: *a*, *a*, newly-hatched larvæ; *b*, full grown larva; *c*, the pupa.

The molting operation. — The moltings of insects are so wonderful, and so little understood, and those of the grasshoppers are so very rarely seen — not once where a thousand are observed of the butterflies and moths — that I borrow the excellent illustrations and explanations of Prof. Riley of the final molting of the Rocky mountain locust, from the 1st volume of the *Report of the U. S. Entomological Commission.* Those who have not access to this volume, or who, among so much other highly interesting material, may have overlooked this portion, will be grateful for this reproduction:

When about to acquire wings, the pupa crawls up some post, weed, grass-stalk or other object, and clutches such object securely with its hind feet, which are drawn up under the body. In doing so, the favorite position is with the head downward, though this is by no means essential. Remaining motionless in this position for several hours, with antennæ drawn down over the face, and the whole aspect betokening helplessness, the thorax, especially between the wing-pads, is noticed to swell. Presently the skin along this swollen portion splits right along the middle of the head and thorax, starting by a transverse curved suture between the eyes and ending at the base of the abdomen.

Let us now imagine that we are watching one from the moment of this splitting, and when it presents the appearance of *a* in Fig. 57. As soon

**Caloptenus femur-rubrum* has been observed by Prof. Riley to deposit four "egg-pods," averaging one hundred and four eggs each, within a period of sixty days, giving an egg-laying period for the species of about two months.

as the skin is split, the soft and white fore body swells and gradually extrudes more and more by a series of muscular contortions; the new head

FIG. 57.—The molting operation of a "grasshopper" (the Rocky mountain locust); *a*, pupa with skin just split on the back; *b*, the imago extruding; *c*, the imago nearly out; *d*, the imago with wings expanded; *e*, the imago with all parts perfect.

slowly emerges from the old skin, which, with its empty eyes, is worked back beneath, and the new feelers and the legs are being drawn from their casings and the future wings from their sheaths. At the end of six or seven minutes, our locust — no longer pupa and not yet imago — looks as at *b*, the four front pupa legs being generally detached and the insect hanging by the hooks of the hind feet, which were anchored while yet it had that command over them which it has now lost. The receding skin is transparent and loosened, especially from the extremities. In six or seven minutes more of arduous labor, of swelling and contracting — with an occasional brief respite, the antennæ and the four front legs are freed, and the fulled and crimped wings extricated. The soft front legs rapidly stiffen, and, holding to its support as well as may be with these, the nascent locust employs whatever muscular force it is capable of to draw out the end of the abdomen and its long legs, as at *c*. This in a few more minutes it finally does, and with gait as unsteady as that of a new-dropped colt, it turns round and clambers up the side of the shrunken, cast-off skin, and there rests while the wings expand and every part of the body hardens and gains strength — the crooked limbs straightening and the wings unfolding and expanding like the petals of some pale flower. The front wings are at first rolled longitudinally to a point, and as they expand and unroll the hind wings, which are gathered and tucked along the veins, at first curl over them. In ten or fifteen minutes from the time of extrication these wings are fully expanded and hang down like dampened rags (*d*). From this point on, the broad hind wings begin to fold up like fans between the narrower front ones, and in another ten minutes they have assumed the normal attitude of rest. Meanwhile the pale colors which always belong to the insect while molting have been gradually giving way to the natural tints, and at this stage our new-fledged locust presents an aspect fresh and bright (*e*). If now we examine the cast-off skin, we shall find every part entire with the exception of the rupture which originally took place on the back; and it would puzzle one who had not witnessed the operation to divine how the now stiff hind shanks of the ma-

ture insect had been extricated from the bent skeleton left behind. They were in fact drawn over the bent knee-joint, so that during the process they were doubled throughout their entire length. They were as supple at the time as an oil-soaked string, and for some time after extrication they show the effects of this severe bending by their curved appearance.

The molting, from the bursting of the pupa-skin to the full adjustment of the wings and the straightening of the legs of the perfect insect, occupies less than three-quarters of an hour, and sometimes but half an hour. It takes place more frequently during the warmer part of the morning, and within an hour after the wings are once in position, the parts have become sufficiently dry and stiffened to enable the insect to move about with ease; and in another hour, with appetite sharpened by long fast, it joins its voracious comrades and tries its new jaws.

Nearly all of the first brood of the hibernating individuals have passed away by the first of August. Eggs had been deposited at various times by those from about the first of June into July. The first larvæ of the second brood may be seen abroad as early as the latter part of June, and continue to appear throughout the following month. The earliest of these maturing and becoming winged about the 10th of August, would toward the latter part of the month deposit eggs for the following brood. Oviposition continues through September, and in September also, young larvæ are again seen. These, from the lower temperature of the advanced season, mature but slowly, and are destined to pass the winter in their immature forms, some of them having progressed to their first pupal stage. They have been observed in Iowa, in very large numbers, abroad in October and November. Mr. A. H. Gleason, of Little Sioux, Iowa (N. Lat. 41° 50′, and Isotherm of 48°) has written as follows of them:

They lay their eggs in August and September, and these hatch (at least some of them) the same fall. I saw them last October and November, little fellows in spots of from one square yard to a twenty acre piece covering the ground as thick as ever I have seen the Western plague [*Caloptenus spretus*]. I have found them in the winter, under the leaves and dry straw and husks that have drifted up under the fences and behind logs in the woods, in a dormant state, and upon warming them they would become brisk as ever (*First Report U. S. Entomolog. Commis.*, 1878, p. 459).

A Double-brooded Species.

It will be observed that this species is an exception to most of the *Acrididæ* in its having two broods a year. That it is double-brooded has not been previously published, but it follows from the observations above recorded, and it is corroborated by the following notes made by Prof. Riley upon the species in Missouri, which he has kindly sent me, for present use:

"Larvæ in different stages, pupæ and winged insects were found May 2d. The winged specimens had not hibernated but matured during April. The winged insects were found till about the 15th of June.

"The first larvæ were noticed June 26th, although there may have been some earlier. The eggs hatch in about fifteen days.

"Winged insects are again found in September, and larvæ in September and October. The latest deposited eggs winter over and hatch during March and April.

"This shows the species to be two-brooded. The first brood, from eggs deposited in the fall, some of which hatch, the larvæ wintering over, while others hatch in spring. Specimens acquire wings from the latter part of April until the middle of June.

"Eggs from the spring brood are deposited the latter part of May and early part of June, and the winged insects from these eggs are noticed in August and September."

Other Double-brooded Species.

It has been claimed by some writers that the Rocky mountain locust, *Caloptenus spretus*, produces two generations annually, but a careful examination of the evidence educed in favor of the claim shows it to be, according to Prof. Riley, "overwhelmingly in favor of normal single broodedness. * * * * * * * * * * While we admit the possibility of a second generation, we believe that it is exceptional, and that the insects composing such second generation seldom, if ever attain maturity or perpetuate their kind" (*First Rept. U. S. Entomolog Commis.*, 1878, pp. 242, 243).

Of *Caloptenus atlanis*, very nearly allied to *C. spretus*, Prof. Riley states (*loc. cit. sup.*), "we have proved it to be double-brooded." This statement should be qualified, by referring it to St. Louis and its more southern localities, for in a communication received from Prof. Riley, he expresses his doubt if, at St. Louis, the second brood is always successful in perpetuating itself, and adds that "later observations in New England convince me that in northern localities it is invariably single-brooded."

In addition to *C. viridifasciata*, we may expect that there will be found to be a spring and an autumn brood in at least several of the species of *Stenobothrus* and *Tettix*, some of which are known to hibernate in the half-grown condition. Of the former, *S. maculipennis* Scudder, shown in Fig. 58, occurs in the State of New York, together with *S. æqualis* Scudd., *S. bilineatus* Scudd., *S. propinquus* Scudd., and *S. cur-*

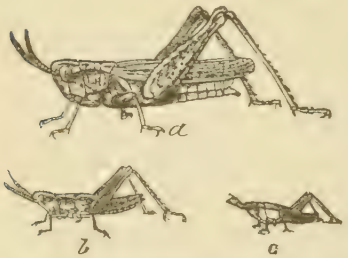

Fig. 58.— Stenobothrus maculipennis —*a*, mature insect; *b*, pupa; *c*, larva.

Fig. 59. — Tettix granulata — the granulated Grouse locust

tipennis (Harris). Of the latter, *Tettix cucullata* (Burm.), *T. triangularis* (Scudd.), *T. granulata* (Kirby), shown in Fig. 59, and *T. ornata* (Say) are also New York species. Dr. Harris seems to record two broods of the last-named species in his statement, that of his *Tetrix sordida* — a synonym of *T. ornata*, he had taken individuals both in May and September.

In all cases in which large numbers of a species of the *Acrididæ* are observed to hibernate in the larval stage, such hibernation may be regarded as presumptive evidence of two generations annually — of a spring and autumn brood.

Remedies.

For the remedial measures to be employed against this species when it occurs in unusual and destructive numbers, the agriculturist is referred to the *First Annual Report of the United States Entomological Commission*, where the various remedies and devices available against the Rocky mountain locust, are discussed at length, in chapter xiii of 70 pages.

[Additional Note. — A remedy that gives promise of being a most excellent one against the grasshopper visitations that occur in the Middle and Eastern United States, has been published in the *Pacific Rural Press* of July 4, 1885. The results attending its use in the protection of vineyards and orchards in California have been of a very satisfactory character. If future experiments substantiate the claim made for its efficient operation, it will prove to be one of the most valuable insecticides thus far given to our fruit-growers and gardeners. It is as follows, as communicated by Mr. D. W. Coquillet, to whom appears to belong the credit of its discovery:

It consists of a mash composed of bran, arsenic, sugar and water, the proportions being one part of sugar, one and one-half parts of arsenic and four parts of bran, to which is added a sufficient quantity of water to make a wet mash. A common washtubful of this mash is sufficient for about five acres of grapevines. Fill the washtub about three-fourths full of bran, add six pounds of arsenic, and mix it thoroughly with the bran; put about four pounds of coarse brown sugar in a pail, fill the pail with water and stir until the greater part of the sugar is dissolved. Then pour this sugar-water into the bran and arsenic, and again fill the pail with water and proceed as before until all of the sugar in the pail has been dissolved and added to the bran. Now stir the latter thoroughly and add as much water as is necessary to thoroughly saturate the mixture, and it is ready for use.

Throw about a tablespoonful of this mixture upon the ground beneath each vine infested with grasshoppers; and in a short time the latter will leave the vine and collect upon the bran and soon commence feeding upon it. Those which are upon the ground six or eight feet from the

bran will soon find their way to it, apparently guided by the sense of smell, as those to the leeward of the bran have been observed to come to it from a greater distance than those which were upon the side of the bran from which the wind was blowing. After eating as much of the bran as they desire, the grasshoppers usually crawl off, and many hide themselves beneath weeds, clods of earth, etc., and in a few hours will be found to be dead.

The mixture costs from thirty-five to forty cents per acre of vineyard, including labor of mixing and applying it. In orchards the cost will be considerably less than this. One man can apply it to eight or ten acres of vineyard in a day.

I have seen this remedy tried on an extensive scale at the vineyard and orchard of Messrs. Kohler, West and Minturn, at Minturn station, Fresno county. In that part of the vineyard which was the most thickly infested by grasshoppers from thirty to fifty dead grasshoppers were found beneath almost every vine, while beneath the adjacent weeds were hundreds of others, the greater part dead. It was also very effectual when placed beneath small fruit trees, the grasshoppers leaving the trees to feed upon this mixture.

The addition of sugar to this mixture is merely to cause the arsenic to adhere to the particles of bran, and not for the purpose of increasing its attractiveness, since it was found that the grasshoppers were not attracted to pure sugar. Middlings or shorts have been used in the place of bran, but are not so desirable, since in drying they assume a solid mass which the grasshoppers cannot eat, whereas bran in drying never assumes a solid form.— D. W. Coquillet, *Atwater, Merced Co.*, June 27.]

Atropos divinatoria (O. Fabr.).

(Ord. NEUROPTERA: Fam. PSOCIDÆ.)

Termes divinatorium MÜLLER: Zoöl. Dan. Prodr., 1776, p. 184, No. 2179.—O. FABR: Fn. Grönl., p. 214, No. 181.—LINN.: Syst. Nat., Ed. Gmelin, p. 2914, No. 8.

Atropos divinatoria HAGEN: Neurop. N. Amer., 1861, p. 8, No. 1; Ent. Month. Mag., ii, 1865, p. 121, No. 1; Stett. Ent. Zeit., xliv, 1883, pp. 289–293.—MCLACHL.: Month. Mag., iii, 1866, p. 180, f. 1.

Troctes divinatorius KOLBE: Psoc., p. 133, No. 1.—PROVANCHER: Faune du Canada, ii, p. 66.

Troctes fatidicus BURM.: Man. Ent., 774, No. 2.

Liposcelis museorum MOTSCH.: Etud., i, p. 20.

The above synonymy of the species is from Dr. H. A. Hagen's *Monographie der Psociden* published in the *Stettiner Entomologische Zeitung* for July-September, 1883.

Remarkable Occurrence of the Insect in Beds.

Numerous examples of the insect were received from Otsego county, N. Y., with a request to return answer what they were and how to remove

them from a room and bed where they abounded. It was thought that they had been left in the room by some traveling agents who had occupied it a year previous. Effort was made to exterminate the insect by hot water and corrosive sublimate. The means used seemed for a while to be successful, but the following year (in April) they again appeared in large numbers.

Answer was returned that they were a low form of the order of Neuroptera, known as *Pscocidæ*, and bearing the scientific name above given.

It was further stated that the insect could not have been introduced in the manner supposed, viz., from the bodies or the clothing of the travelers, for the reason that, although in general appearance it is quite louse-like, yet it does not belong to the *Pediculidæ*, and is not parasitic upon the persons of men or animals. It frequently occurs in books and among old papers, and is known also to feed upon the remains of minute insects, and to attack the insects in entomological collections. Its mouth parts are not fitted for sucking blood but consist of strong cutting jaws.

Recommendations for its Destruction.

To remove the insects from the bed, it was recommended to wash the entire bedstead with hot water and soap-suds, or to brush over the entire surface with benzine, if it could be done without injury to it. Such portions of the bedding as could not be washed, as the pillows and mattress, should be exposed to the hot sunlight for two or three days, turning them from side to side occasionally. A feather-bed might require some benzine to be poured into it, and the contents of a straw tick should be burned.

If the room was infested to any considerable extent, if papered, the old paper should be removed, and the walls thoroughly washed before re-papering. Carpeting should be treated as recommended for the bedding, and the floors and the entire wood-work washed with strong soap-suds.

Particulars of the Invasion.

The absolute certainty expressed by the lady from whom the specimens were received, that they had been introduced into her house by the travelers above stated, and the certainty, from an entomological standpoint, that they could not have been thus introduced, led to considerable correspondence upon the subject, which elicited minute and extended particulars respecting the suddenness of the invasion, its abundance, its persistence, and fruitless efforts to conquer it. These proved to be of considerable interest in their economic aspect, as will

be seen from the extracts upon these several points, that we make from the letters sent to me.

"The room had been newly papered two years ago, and an almost new rag carpet was on the floor. In two recesses were cord bedsteads which had never been used except as 'spare beds.' Last spring the room was cleaned, but the carpet was not taken up. The strawbeds were newly filled, the straw of which was all right [in answer to the suggestion that the straw might have been infested], for with three other beds filled with the same there has been no trouble. The floor underneath the bed is not carpeted. The foot-curtains had been ironed and put up the afternoon before the bed was occupied by the men. I know the beds and room were clean as could be, with no vermin present. I never keep any thing but a light spread on my spare beds. I made the bed with clean sheets and a comfortable and bed-quilt from the closet.

"The bed was occupied for the night by two young men who were taking orders for enlarging photographs and finishing in India ink. They had no luggage with them or any packages except the cases containing pictures.

"In the morning, about an hour after their departure, the bed was opened, and in the sheets were large vermin (lice) [these were not sent]. The sheets were carefully gathered up and brought down stairs, and out of doors. The bed-quilt, comfortable and bed-curtains were literally covered with the creatures such as I sent you. * * * The bed not slept in was worse, if possible, with these little specimens than the one occupied. We think the men must have distributed their garments around the room. That afternoon I washed the sheets, pillow cases, straw-ticks and curtains of both beds. We threw the bedding out of doors, and killed all that we could find, and then ironed them on both sides. The bedsteads we washed in hot water and with hot brine where they would not be injured by it, and the floor the same. While they were yet damp, we took Persian insect powder and puffed it into every crevice in the floor and bedstead.

"No [in reply to question], there are none elsewhere in the house, and never *there*, until these lodgers left them. We did not settle the room again for weeks, but kept up a diligent search, and every few days would find two or three. The last warm weather in the autumn, I found quite a number on the fine pillow cases next the ticks. I had the straw tick emptied and washed again, and ironed the bedding. I kept the window raised during most of the winter, hoping that the extreme cold would put an end to them. But to my surprise the first warm day this spring, I found the white spread on the bed where they slept almost covered again, from which I gathered those last sent to you. I never have found them larger [reply to question]. They do not soil a white spread when I kill them on it. They will be in clusters, frequently, of twenty or more. They appear to like white goods, cotton or linen. I have continued my warfare upon them faithfully while waiting to hear from you. I took up the carpet, but there was nothing in it or under it, not even dust, it was so clean. We uncorded the bedsteads and examined them, but there was nothing in them. I do not think that they incline to wood or wall.

"Gasoline is the most effectual of any thing that I have tried for killing

them. One hundred dollars would be no temptation to me to pass through such a trial again, even if I have suceeded now in subduing them. I had cared for the room twenty-three years, and never saw any thing of the kind before. It was not *so* when the men retired, and was literally alive an hour after their departure. I know that it seems incredible, but my testimony can be fully substantiated. There are some that *dart* so that I cannot trap them. It seems to me that they are in different stages of development, or perhaps different varieties."

The Possible Source of the Insects.

I know of no other instance in which *A. divinatoria* has occurred in this country, in an abundance equal to the above, nor am I able to offer any explanation for its sudden appearance. The only suggestion as to its source that presents itself is this; its possible introduction with the straw used in filling the straw-ticks, notwithstanding the statement that other beds filled with straw from the same source were not infested. Species of *Psocidæ* are known to abound in barns. Dr. Hagen informs me that he had, on one occasion, found more than half of the refuse material left in a barn after threshing the grain to consist of a small species of Psocus. Mr. McLachlan, of London, England, has found "myriads" of this same species, *Atropos divinatoria*, in the straw bottle envelopes in the wine cellar of his house, associated with *Clothilla picca*. Examples of *Clothilla pulsatoria* (to be noticed hereafter) have been sent to me for name, taken from cattle-stalls, in Warren, Ohio, where they were abounding, and from the locality that they occupied, were supposed to be cattle-lice.

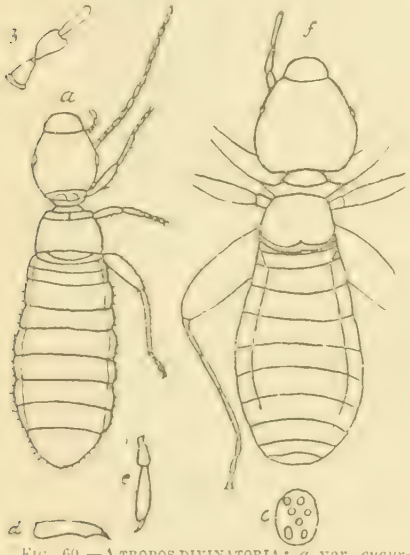

FIG. 60.—ATROPOS DIVINATORIA: *a*, var. *cucurbitæ*; *b*, side-view of basis of antenna; *c*, eyes; *d*, claw; *e*, tarsus of nympha; *f*, *A. divinatoria*, drawn from life.

Description of the Insect.

The American forms of this species have been found by Dr. Hagen to differ in several particulars from the European ones, but as these differences are mainly colorational, they are regarded as identical. They have been minutely described by Dr. Hagen in "Beiträge zur Monographie der Psociden — Familie Atropina," in *Entomologische Zeitung, entomologischen Vereine zu Stettin*, 44, 1883, pp. 285–332, and figured in the same publication (Plate ii, Fig. 4) of the preceding year. To these,

the student who may desire knowledge of the species, is referred. In lieu of description, the accompanying figures (Fig. 60) are presented, which will serve for the identification of the species. They are copied from the plate above referred to.

Habits of the Psocidæ.

Of the general habits of the *Psocidæ* Westwood remarks that they frequent the trunks of trees, palings, old walls, stones covered with lichens, old books, &c., for the purpose of feeding either upon the still more minute animalculæ which inhabit those situations, or, more probably, upon the decaying vegetable matter to be there met with. They are extremely active, and when approached, they endeavor to hide themselves by running to the opposite side of the tree, or other object on which they are stationed. The perfect insects are produced toward the end of summer, when they sometimes appear in great numbers. The larvæ and pupæ are equally active with the imago, from which the former differ in being apterous, while the pupæ have rudimental wings (Westw. *Classification of Insects*, ii, 1840, p. 18).

The Death-Watch.

An interesting member of the family is the *Clothilla pulsatoria*, of which a figure is presented from Packard's Guide, which may not, however, be accepted as a strictly accurate one. It is a small white insect, often found in old papers, books, exposed collections of insects, etc. It occurs both in this country and in Europe, and has obtained, in the latter, the common name of the *Death-watch*, from the tapping noise which it produces resembling the ticking of a watch. To the superstitious of past ages the tick, audible only in quiet and frequently heard in the silence of a sick-room, proceeding from an invisible source, was regarded as an ill omen, predicting approaching death. A small wood-boring beetle occurring in Europe, *Anobium tesselatum* Fabr., is also sometimes known as the *death-watch*, and two or three other species of the genus have the ability of producing the same ticking sound.

Fig. 61.— The Death-watch, Clothilla pulsatoria, greatly enlarged.

Literature of the Psocidæ.

The following is some of the more easily accessible literature of the *Psocidæ* that may be consulted by those who would know more of this interesting group, and acquaint themselves with some of our species :

WESTWOOD: Introduc. Class. Ins., ii, 1840, pp. 17–20 (general notice of family).
GLOVER: in Rept. Comm. of Agricul., 1858, p. 263 (brief notice).
HAGEN: Synop. Neurop. N. A., 1861, pp. 7–14 (describes 18 species); in Proc. Ent. Soc. Phil., ii, 1863, pp. 167–8 (observations on 6 species); in Ent. Month. Mag., ii, 1865, p. 122 (Clothilla annulata); in Psyche, iii, 1881, pp. 195–6, 207–210, 219–223 (Psocina of the U. S.); id., iv, 1883, p. 25 (tarsal and antennal characters); in Stett. Ent. Zeit., 1883, pp. 285–332, pl. 2, in S. E. Z., 1882 (Monographie der Psociden).
FITCH; In Trans. N. Y. St. Agricul. Soc., xxii, 1862, pp. 668–675; 8th Rept Ins. N. Y., in 6th–9th Repts, 1865, pp. 186–193 (five new species of Smynthurus described and noticed).
WALSH: in Proc. Ent. Soc. Phila., ii, 1863, pp. 182–186 (describes 7 n. sp., and remarks on others).
HARRIS: Entomolog. Corr., 1869, pp. 327–332 (describes 7 species).
PACKARD: Guide Stud. Ins., 1869, pp. 588–590, fig. 573 (general remarks).
SCUDD.-BURG.: in Psyche, ii, 1877, pp. 49–51, 87–89 (head-structure of Atropos).
ASHMEAD: in Canad. Entomol., xi, 1879, pp. 228–9 (P. citricola, n. sp.); Orange Insects, 1880, pp. 37–38 (orange Psocus), 71–2 (habits of P. venosus).
MCLACHLAN: in Entomol. Month. Mag., xix, 1883, pp. 181–185 (descriptions and generic criticisms).
AARON: in Trans. Amer. Ent. Soc., xi, 1884, pp. 37–40 (new species in Coll. of Soc.).

Achorutes nivicola (Fitch).

The Snow-Flea.

(Ord. NEUROPTERA: Fam. PODURIDÆ.)

Podura nivicola FITCH: in Amer. Quart. Journ. Agricul.-Sci., May, 1847, v, p. 284; Id., for September, 1847, vi, p. 152; Winter Insects of Eastern New York (sep. from prec.), pp. 10–11.
Podura nivicola. ASHTON: in Proc. Ent. Soc. Phil., i, 1861, p. 32.
Podura nivicola. WALSH-RILEY: in Amer. Entomol., i, 1869, p. 188 (in Wisconsin).
Achorutes nivicola PACKARD: in Fifth Ann. Rept. Peabody Acad. Sci., July, 1873, pp. 29–30.

Specimens of this winter insect were received from Mr. John M. Dolph, for name, with the information that they were found abundantly at Port Jervis, N. Y., on the 25th of January, both upon the surface of the snow and in pools of water made by the melting snow.

Although this is said to be a common and abundant insect, yet it would appear to be rather a local one, for, when occurring in large numbers upon the snow, it could scarcely fail of arresting attention. It certainly is not often observed, even by entomologists. I can only recall one instance in which it has fallen under my observation.

Habits.

Dr. Fitch has remarked as follows of it: "This is an abundant species in our forests in the winter and forepart of spring. At any time in the winter, whenever a few days of mild weather occur, the surface of the snow, often, over whole acres of woodland, may be found sprinkled more or less thickly with these minute fleas, looking, at first sight, as if gunpowder had there been scattered. Hollows and holes in the snow, out of which the insects are unable to throw themselves readily, are often black with the multitudes which here become imprisoned. The fine meal-like powder with which their bodies are coated enables them to float buoyantly upon the surface of the water, without becoming wet. When the snow is melting so as to produce small rivulets coursing along the tracks of the lumberman's sleigh, these snow-fleas are often observed, floating passively in its current, in such numbers as to form continuous strings; whilst the eddies and still pools gather them in such myriads as to wholly hide the element beneath them."

Notices of its Observation.

Mr. T. B. Ashton, of Washington county, N. Y., has given the following account of his observation of this insect, in a paper read before the Entomological Society of Philadelphia:

Podura nivicola Fitch. — Found on the 18th of April, weather cloudy and cold, with temperature above 50° Fahr. This insect was met with in countless numbers on and near a swampy piece of ground, through which ran a small creek. My attention was first directed to what I supposed to be soot floating down the creek, and paid no farther notice to it until I discovered the insect in large numbers in the highway, a few rods distant from the creek, and then suspecting the cause of the soot-like appearance floating on the water, I returned, and to my surprise, found countless millions of them alive and active, piled upon each other to the height of half an inch, and in spots varying from an inch or less to twelve inches in diameter, floating on the water in every eddy, for a distance of about thirty rods.

I also observed them in vast numbers, in every direction for rods around the creek. This was the only place that I met with them on that day, though I passed over, on foot, a tract of country fifteen miles in extent.

The following notices, in all probability referring to this species, are from *Field and Forest*, vol. ii, 1877, pp. 146–7.

Charles M. Nes, of York, Penn., writes to the Smithsonian Institution, that with the snow-fall of the 8th of January (about twelve inches) there appeared myriads of "spring-tails," or *Podura*, samples of which were inclosed, covering the surface of the snow to such an extent as entirely to discolor it. The phenomenon extended over an area of country two miles in length, and half a mile in width. In a later communication Mr. N. says: "They were in clusters, and where I gathered the specimens, I had simply to take them up by handsful; the snow was literally covered. They still exist in great quantities on fences, bushes, stones, etc., in the vicinity where they first fell.

Dr. J. G. Morris, of Baltimore, also reports a similar appearance about ten miles north of Baltimore, about the same time; and last season they were observed in numbers near Sandy Spring, Maryland.

Description.

The original description and comparisons are the following:

Black or blue-black: legs and tail dull brown.

Length, 0.08 inch.

Body black, covered with a glaucous blue-black powder but slightly adherent, and sparingly clothed with minute hairs; form cylindrical, somewhat broader towards the tail. *Antennæ* short and thick, longer than the head. *Legs* above blackish, beneath dull brown and much paler than the body. *Tail* of the same color with the venter, shortish, glabrous on its inner or anterior surface, with minute hairs on the opposite side; its fork brownish.

Though found in the same situations as the European *P. nivalis*, ours is a much darker colored species. Say's *P. bicolor* is a larger insect than the one under consideration, and differs also in size and in the color of the tail or spring. From the habits of the present species, we should infer that it might be abundant in all the snow-clad regions of the northern parts of this continent; it may, therefore, prove to be identical with *P. humicola* of Otho Fabricius (*Fauna Gröenlandica*) of which we are unable to refer to any but short and very unsatisfactory descriptions, which do not coincide well with our insect (*Winter Insects of Eastern New York*, pp. 10–11).

Other closely allied species of the genus having subsequently been described, the above description would hardly suffice for its positive identification. Its more detailed description by Dr. Packard is therefore given:

Achorutes nivicola. Podura nivicola Fitch, Winter Insects, N. Y.

Antennæ four-jointed, short, thick, of nearly even width throughout; first joint as long as thick, second and third both of the same length, but second considerably thicker; fourth a little longer than third, and but slightly thinner. Feet with a large claw arising from a small joint of the usual form, with a long, slender, tenent hair arising near the claw. The anal appendages appear to be really two-jointed, and consist of two spine-like appendages, with a common base and hollow at basal half. Just below their middle is a joint, with a very slightly marked suture externally. They are borne on a broad triangular tergite (that of the

sixth segment), while low down on the side of the body are the anal valves, rounded and small compared with the tergite. Tenaculum [the catch for holding the spring] with basal joints quadrate in profile, the external edge being a little roughened. From between them project V-like a pair of short, subtriangular blades, a little longer than broad, and with four large teeth on the under side. Elater [the spring] short and broad, the two finger-shaped joints about twice as long as thick; second joint very minute, consisting of a thin lobe rounded at tip and a little uneven on lower edge, and with a prominent spine at base; two hairs on inside of basal joints. Dark lead color, above and beneath. Body long and slender, abdomen rather suddenly contracting just before the three terminal segments.

Length, 0.08–0.10 inch.

Hundreds of specimens seen with no appreciable variations. Very young, white.

On snow in March; under bark of trees, Salem, May 28 and June 6. (Packard: in *5th Rept. Peab. Acad. Sci.*)

Associated Species.

The following named features will serve to separate the above from the other described species:

Achorutes boletivorus Packard, is a much smaller species, being only about one-half the size (0.05–0.07 inch) with a thicker body, smaller head proportionately, and shorter antennæ. It differs materially in color, being pale gray above with a slight greenish tinge, lined with white beneath, and with gray specks on the sides.

Occurring September 10, abundantly between lamellæ of Boleti and Agaricus, and under horse manure in August.

Achorutes pratorum Packard. Resembling *A. nivicola*, but smaller (0.04–0.06 inch), of a considerably lighter lead color, paler beneath, and with a lateral row of dark irregular spots, one to each segment. The hairs upon the body are more numerous. Its spring (elater) is much longer and more slender, the second joint long, slender, cylindrical, distinctly separated from the base by a suture; the third and terminal joints much longer and more slender. It occurs on the surface of pools, and in open grounds after rains, and is quite active in its habits. July and September.

Achorutes marmoratus Packard. Approaches the preceding in form of body and of the spring. It is of a pale gray color, marbled with large lilac-gray patches above; beneath paler. Length 0.05 inch.

Achorutes Texensis Packard. A small species (0.04–0.05 inch), occurring in Texas, of the same color with *A. nivicola*, resembling *A. pratorum* in structure, but with its spring twice as large as in that species.

The Family of Poduridæ.

The *Poduridæ*, from their degraded structure, form one of the lower classes of insects. By most writers, they have been classed with, and

at the end of, the Neuroptera, but by some systematists they have been united with the *Lepismatidæ* (bristle-tails) into a separate order, known as Thysanura. They have been so referred by Dr. Packard in the last edition (8th, of 1883) of his *Guide to the Study of Insects.*

They are small species, varying from 0.04 to 0.16 of an inch in length. The largest species, *Orchesella flavo-picta* Packard, occurs in Albany, under bark of stumps.

They are commonly known as "Spring-tails" from the flexible anal stylet which is bent beneath the body, serving as a spring, by means of which they are enabled to make extraordinary leaps when compared with their diminutive size. They are commonly found beneath bark, stones, sticks, boards, in crevices of wood, in cellars, in garden hotbeds, on snow, pools of water, damp earth, manure, Boleti and Agarics, and in various other similar locations.

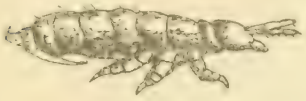

FIG. 62.—ACHORUTES PURPURASCENS—enlarged to 18 diameters (After Murray).

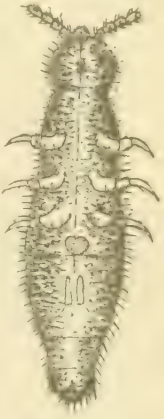

FIG. 63. — ACHORUTES PURPURASCENS, showing under side.

As illustrative of the genus to which the snow-flea belongs, an European species, *Achorutes purpurascens* (Lubbock), is copied (Fig. 62), from Murray's *Economic Entomology.* In Fig. 63, another view, copied from *Science Gossip*, of the same insect is presented showing its under surface, and the short forked spring characterizing the different species of this genus.

A different type of the *Poduridæ* is shown in Fig. 64, in *Symnthurus hortensis* Fitch, in which the short and nearly spherical form approaches the spiders. It occurs abundantly in May and June, in gardens, in the State of New York, upon the leaves of young cabbages, turnips, cucumbers, and many other plants. It is believed to be injurious to the vegetation upon which it is found, through its continuing the attack made by the flea-beetles and other insects of similar habits, and enlarging the wounds or perforations made by them, by feeding upon the soft matter formed by the evaporation of the exuding juices. It is an active insect, and quickly skips from the leaf, if disturbed, to the ground. For an interesting description of the peculiar apparatus — the forked spring and catch — by means of which its leaps are made, see Fitch's 8th Report (6th–9th Reports, p. 188).

FIG. 64.—The Garden-flea, SMYNTHURUS HORTENSIS Fitch, greatly enlarged, with antennæ still more enlarged (after Fitch).

Lipura fimetaria (Linn.).

(Ord. Neuroptera: Fam. Poduridæ).

Podura fimetaria Linn.: Syst. Nat., 12th edit., 1766, p. 1014.
Lipura fimetaria Pack.: in Amer. Naturalist, v, 1871, p. 106, f. 38; in 5th Rept Peab. Acad. Sci., 1873, p. 29.
Lipura fimetaria. Murray: Econom. Entomol.—Aptera, p. 412, f. 21.
Lipura fimetaria. Lintner: in Count. Gent., xliv, 1879, p. 327; id., xlv, 1880, p. 103.

This little species of the *Poduridæ*, frequently found in damp localities, but scarcely regarded as of economic importance, has in two instances been brought to my notice under circumstances that made it of more than usual interest — in one instance abounding in a cistern, and in the other in a well used for household purposes.

With the first, the following communication was sent:

Its Occurrence in a Cistern.

Please find inclosed some strange insects that I found in my cistern about three weeks since [in January]. The cistern is a large one, with a small receiving cistern near it, from which the water is filtered into the large one. During the last severe weather the pump froze and broke. I then ordered water to be drawn with pole and bucket. The first bucketful drawn up appeared to have hundreds of these little white insects in it, and they continued to come up with every bucketful. These I have had in a glass goblet in a warm room for the last three weeks. The cistern has been built a little over two years, and has a close-fitting iron cover on it. There is no wood in or around it. Where did these insects come from?

The insects were alive when received, and although they had been confined for two days, at least, in a homœopathic vial, they were found quite active upon the surface of the water. Their tenacity of life is somewhat remarkable, for it is recorded of this species that it has been kept in confinement from September until the following June.

In reply to the communication, assurance was given of their harmless character in the location found, as they could only act as scavengers, serving to remove impurities. In answer to the question where they came from, it was stated that the species occurred under damp sticks or wet pieces of wood. A favorable locality for it would be under the roof shingles projecting over a wooden gutter, through which, washed off by the rains, they could be readily conveyed into a cistern, and, from their fecundity and rapid propagation, soon become greatly multiplied. As they live upon the surface of the water, their presence would

not be detected so long as a pump was used unless the water had been reduced to the level of the bottom of the pipe. A bucket dipping from the surface would at once bring them to notice.

Occurrence in a Well.

Another communication contained the following statement:

I inclose to you by mail in a bottle, four or five small insects which are drawn up in the bucket of my well quite frequently. Can you inform me what they are, and in what way they can be most easily exterminated? The well is dug in a sandy clay, and is made of two and a half foot cement pipe, the joints being cemented, and I fully supposed it was worm, insect and vermin proof. At times hundreds are drawn up in a day. They seem to live only on the surface of the water.

As to their occurrence in the well, it was suggested in reply, that if the well was an open one, the insects would originally have been attracted by the cool, damp sides of its walls, and thence easily have found their way to the water. It was no doubt somewhat disagreeable to see living forms in association with water which we drink, but beyond this, the presence of the *Poduridæ* in the well was not objectionable. As in the case of those occurring in cisterns, they would undoubtedly serve an excellent purpose in feeding upon and removing many of the impurities that, without them, would accumulate upon the surface, to the detriment of the healthfulness of the water. In the event, however, of their becoming annoyingly abundant, it was thought that they could be diminished by dropping a moderate quantity of finely powdered lime into the well.

Its Appearance and Habits.

We find among our writers no detailed description of this species, nor good figure, and we therefore copy a rather crude one from Murray's *Economic Entomology*, to aid in its identification. Fig. 65 gives a dorsal view of the insect. Although contained in the Tribe Collembola, which consists largely of the "spring-tails," this species is without the jumping apparatus of the one previously noticed. Dr. Packard, in his *Synopsis of the Thysanura of Essex Co., Mass.*, places it in the subfamily of *Lipurinæ*, and characterizes it briefly as being white, naked, with a few scattered hairs, and of the length of 0.06 of an inch. It is rather blunt at the tip, and is without the hooks at the end of the abdomen that occur in an associate species, *Lipura ambulans* (Linn.).

FIG. 65.—LIPURA FIMETARIA (Linn.), enlarged to ten diameters (After Murray).

Its habits appear to be quite varied, for beside living upon the surface of water after the manner of *Anurida maritima* (Linn.), *Podura aquatica* Linn., and others — according to Murray, it is found upon damp earth, in Europe, throughout the year, often engaged in browsing upon carrots, potatoes, or other roots.

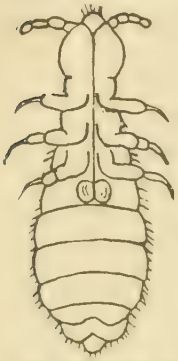

FIG. 66.—ANURIDA MARITIMA, enlarged 25 diameters.

Fig. 66, copied from an article upon some English Thysanura in *Science Gossip* for 1873, is of *Anurida maritima* — a small, dark blue velvety Podura, inhabiting the wet sea-weed, the loose shales between tides, and the rock-pools of the English, Irish and French coasts; also upon the eastern sea-coast of the United States, at Salem, Mass., at Nantucket, and on the New Jersey coast, floating on seaweed, or hidden under stones between tide marks (Packard). The figure gives a ventral view of the insect, and shows the absence of the abdominal spring — a distinguishing feature which separates the genera of *Anurida*, *Lipura*, and *Anura* from the other *Poduridæ*.

APPENDIX.

(A.)

ENTOMOLOGICAL CONTRIBUTIONS.

The two following papers are republished in this place, for convenience of reference, and as being a portion of the work of the Entomologist during the period for which his report is made.

[*From Psyche, Novem.-Decem.*, 1883, v, *pp.* 103-106.]

A NEW SEXUAL CHARACTER IN THE PUPÆ OF SOME LEPIDOPTERA.

(Read before the American Association for the Advancement of Science at its Montreal meeting, August, 1882.)

The sexual characters of insects have always been an interesting study to the entomological student, the more so as they are the less apparent, and discoverable, if to be found at all, only as the result of close observation and comparison. In the larger proportion of insects, in the perfect stage, they are so marked as to leave no doubt of the sex when the male and female are compared. Thus in the Hymenoptera, we have the ovipositor in its varied forms, often quite conspicuous. In the Lepidoptera; among the *Heterocera*, there are usually the more fully developed antennæ of the male, and the broader, conical and more capacious abdomen of the female — features attaining their maximum development in the family of *Bombycidæ*. In the Diptera, there are the larger and more approximate eyes in the male, and conspicuous structural differences in the antennæ and suctorial apparatus in some of the families. In the Coleoptera, there are often, in the male, stouter legs, broader tarsi, greatly elongated mandibles and other horn-like caputal and thoracic processes. In the Hemiptera, the vocal organs in the *Cicadidæ*, the ovipositor in several of the families, and the great sexual differences in size and in the presence or absence of wings are prominent features. In the Orthoptera, there are the stridulating wing-nerves, the extended ovipositor, and a genital armature greatly varied in its adaptation to greatly differing habits. And in the Neuroptera, distinctive male characters are found in clasping organs, in differences in color and in size, the long mandibles of *Corydalus*, the abnormal location of the intromittent organ in *Libellulidæ*, and in the elongated and forcipated genitalia of *Panorpa*.

In addition to such primary features as above noted, there are numerous secondary ones, which do not appear to be so dependent upon sex,

and many of which seem almost to serve no higher purpose than that of ornamentation. Yet it is reasonable to believe that most of these differences have their use in the economy of nature, and that they aid in the continuance of the species.

Among such minor antigenetical features may be mentioned, in the Lepidoptera, the usually more angulated wings of the male; the simple frenulum of the most of the male *Heterocera* in contrast with the compound one in the female; the hairy anterior legs of *Grapta* and *Vanessa* in the *Nymphalidæ*; the long hairs between the costal and subcostal nervures, above the cell of the hind wings of *Argynnis*, appearing when displayed in the cabinet, like a long fringe to the inner margin of the front wings; the incrassated, black, scale-patch upon the middle of vein 2 (the 1st median nervule) of the secondaries of *Danais*; the ovoid discal spot on the front wings of many of the *Theclinæ*: in the *Hesperidæ*, the reflexed costal margin in most of the *Nisoniades*, *Eudamus* and *Pyrgus*, and the tibial epiphysis* of the anterior legs in all but one of our genera; the transverse discoidal stigma on the primaries of most of the species of *Pamphila*; the beautiful and peculiar microscopic (often concealed) scales, or androconia, of many of the butterflies; the usually concealed pair of extensile anal appendages found by Fritz Müller and others in certain *Glaucopidæ*, *Bombycidæ*, *Noctuidæ* and in a *Danais*,† — each of these several characters indicating the male sex. Features equally interesting, and alike serving no purpose so far as known, might be mentioned in each of the orders of insects.

In the earlier stages of insects (egg and larval), sexual features, as would naturally be expected, are less numerous and less conspicuous. They rarely occur in the first stage — that of the egg, or more properly, they have not, in many instances, been recognized by us.‡

It was for a long time believed that in the larva of one of our *Sphingidæ* not unfrequently met with — *Thyreus Abbotii* — the sex was so clearly indicated by difference in color and pattern that it could be told at a glance. Of the two greatly differing forms, the one marked with a series of large yellow-green patches on the dorsum extending half-way down the sides, and with another row of smaller subtriangular similarly colored spots resting on the prolegs, was described by Clemens as the male; the female being reddish brown throughout, with a dark brown subdorsal stripe and numerous short broken striæ.§ This sexual determination of

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* Guenée: Hist. Nat. Ins., 1852 — Lepid., v. — Noct., i, p. xxxv. — Speyer: in Canad. Entomol., 1878, v. 10, p. 124. Edwards' Catal. Lep. Amer., 1877, p. 64.

† Fritz Müller: Nature, 11 June, 1874, v. 10, p. 102 (Psyche, Mar.-Apr. [9 July], 1877, v. 2, p. 24). Morrison: Psyche [9], Oct. 1874, v. 1, pp. 21–22. Siewers: Canadian Entomologist, Mch. 1879, v. 11, pp. 47–48, fig. 12. Stretch: Papilio, Feb., 1883, v. 3, pp. 41–42, fig.

‡ In *Phylloxera*, the eggs which are to produce males and females may be known by their difference in size. See Riley's Annual Reports of the State Entomologist of Missouri: 6th, p. 41; 7th, pp. 92–98; 8th, p. 158.

§ Two colored figures of the larvæ in my possession, made by Dr. Clemens, show the sexes the reverse of this — the green-spotted one marked as ♀, being much the larger of the two.

Clemens was accepted by me in my paper upon the larvæ and pupæ of this species in the 26th Report of the New York State Museum of Natural History, pp. 114-116, and has also been followed by other writers. That the two forms are indicative of sex, has since been denied,* and it is to be presumed that the denials are based upon results obtained in rearing them to their perfect form. The green-spotted larva may, therefore, be accepted as a dimorphic form, comparatively rare in my own collections and in the examples that have come under my observation.

The young collector of insects learns very early the simple method of determining the sexes of his Luna, Polyphemus, Promethea, and Cecropia pupæ, and of many other bombycid pupæ, by observation of the comparative breadth of their antennal cases.

A means by which the sex in the pupæ of the *Sphingidæ* may be infallibly named, was pointed out by me in the *Proceedings of the Entomological Society of Philadelphia*, 1864, v. 3, p. 654. I have since found the same characters applicable to the *Noctuidæ* and to other *Heterocera*.

Prof. C. V. Riley, in the *Transactions of the Academy of Science of St. Louis*, 1873, vol. 3, pp. 128–129, and in the *6th Annual Report of the State Entomologist of Missouri*, for 1873, 1874, pp. 131–132, has described and figured sexual differences in the pupæ of *Pronuba yuccasella*, consisting mainly, in the greater length of the "dorsal projections" on the several segments of the male, in the length of the last two segments as compared with those of the female (its shorter 11th and longer 12th), and in its less rounded apex. He says: "Sexual distinctions are very rarely observable in chrysalids; but after I had learned to distinguish between them, I could readily separate the sexes in this case, and my judgment was confirmed upon the issuing of the moths."

A few years ago I discovered an interesting feature in the armature of the species of *Cossus*, by which the sex may at once be determined. I have hitherto withheld its publication, until I had studied others of our spined pupæ and could illustrate this feature by proper figures; but the opportunity for this has not been found, and I accordingly defer no longer calling attention to it, that the observations of others in possession of more abundant material may supplement the few that have been made by me.

It is known to lepidopterists that most of the pupæ of the species of moths which in their larval stage live in the interior of stems of plants and trunks of trees (endophytes), are armed upon their abdominal segments with transverse rows of teeth or spines, by the aid of which, when they are in readiness for their final transformation, they gradually work their way through the outer packing of their gallery and the bark, project their anterior segments to at least one-third the entire pupal length through the opening, and hold themselves securely during the eclosion of the moth.

* Whitney: Canadian Entomologist, April, 1876, v. 8, pp. 75–76. Grote: *id.*, May, 1876, p. 100.

This useful armature in the *Cossinæ*, and in such of the *Ægeriidæ* as I have had the opportunity of examining, consists of two rows of spines upon most of the abdominal segments, dividing them, when seen in extension, in three nearly equal parts. In *Cossus robiniæ*, the species of the *Cossinæ* with which we are probably the most familiar, these rows occur on the fifth (the first stigmatal segment posterior to the wing-cases) and the following segments.

In *Cossus querciperda* alone of the species known to me, they commence in a single row of minute dentations on the fourth segment. The principal features of this armature are the following: It is always the stronger in the male sex — conspicuously so in *C. robiniæ*, but less so in *C. Centerensis:* the teeth increase in size from the fifth to the tenth segment: the anterior row is always the stronger in each sex; upon the fifth and sixth segments, it does not, in its lateral extension, reach below the stigma,* while upon the following segments it passes in front of the stigma and quite a distance beneath it; the posterior row is discontinued before reaching the line of the stigmata; the teeth show irregularity in form and size, particularly those of the posterior row.

The sexual distinction above referred to, presented in this armature, is this: in the male pupæ two rows of teeth occur on segments five to ten inclusive; in the female, two rows on five to nine inclusive. In other words, *the male pupa shows* TWO *rows of teeth on segment ten, where the female shows but* ONE [as illustrated in Fig. 67, of a pupa-case of *C. Centerensis*, from which the moth had emerged]. In each sex, the eleventh and twelfth have but a single row. Disregarding, as I think we should in ordinary usage, the subdivision of what is usually known as the terminal segment, into demi-segments, or a segment and a subsegment, and that still further refinement which would make of the extreme portion an additional segment with full numerical designation, then it will serve to prevent misapprehension of the particular section showing the sexual feature, if we indicate it as the *antepenultimate segment*. It would be the eleventh, if we commence enumeration, as some of our entomologists do, with the head, but the tenth, if, as seems to me more proper, we begin with the first thoracic ring.

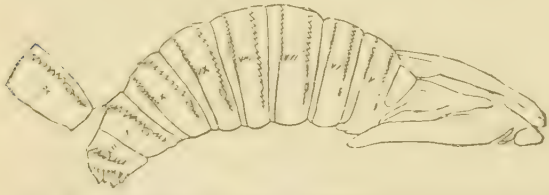

FIG. 67.—Pupa-case of COSSUS CENTERENSIS, male (the moth emerged), with tenth segment of a female pupa-case—enlarged.

Besides the *Cossinæ*, this same sexual feature occurs in the *Ægeriidæ*. I am not able to say if it extends throughout the entire family. At the time of this present writing, I have at my command only the pupæ of *Ægeria exitiosa* and *A. tipuliformis*, and it exists in each. It probably occurs in the pupæ of *Zeuzera* (one North American species described), in which the two rows of teeth are found on several of the segments, and per-

* In *C. Centerensis* it reaches below the stigma on the sixth segment.

haps also in *Hepialus*, the pupæ of which (unknown to me) are characterized as very similar to those of *Cossus*.

Another interesting fact connected with the armature of *Cossus* is that the form, size and position of the teeth vary to so great an extent in the different species, and show such distinctive characters, as to afford excellent specific features.* I would not hesitate to pronounce upon specific identity, upon an examination and comparison of the pupal armature alone.

[*From Psyche, May-June*, 1883, iv, *pp.* 48-51.]

ON AN EGG-PARASITE OF THE CURRANT SAW-FLY (NEMATUS VENTRICOSUS).

(Read before the American Association for the Advancement of Science, at its Montreal meeting, 29th August, 1882.)

Dr. Asa Fitch, in his *12th Annual Report on the Insects of New York* for the year 1867 (*Trans. N. Y. State Agric. Soc.* for 1867, 1868, v. 27), pp. 931–932, made the following reference to this insect:

As none of the foreign accounts which we have seen allude to any parasitic enemy of this currant saw-fly, it seemed quite improbable that it would in this country meet with any such enemy, to lighten from us the task of combatting it and diminishing its devastations. But our valued friend, J. A. Lintner, of Schoharie, greets us with the glad tidings that he has discovered we have such a foe to this formidable scourge. An egg parasite of this saw-fly inhabits our State, an exceedingly minute hymenopterous insect, which inserts its eggs into those of the saw-fly, that its young may subsist upon and consume the contents of those eggs. This diminutive little fly has probably existed hitherto upon the eggs of some one of our American saw-flies similar in size to those of the currant saw-fly; and it has now discovered that the eggs of this newly-arrived foreigner are equally well adapted to its wants. And so multiplied has this little friend of the gardener become, that in Utica, Mr. Lintner finds that among fifty eggs of a saw-fly upon a currant leaf, there will not be more than four or five that will hatch currant worms, all the rest being occupied by the little maggot, the young of this parasite. At Schoharie, also, where the saw-fly has arrived more recently than at Utica, he finds this parasite is now beginning to appear. Everywhere this little creature is no doubt following upon the tracks of the saw-fly, and within a very few years after the one arrives in any place the other will be there also, and will speedily become so multiplied as to quell and extinguish it. This is a most important discovery, and renders it quite probable that in this country this currant worm can never be but a temporary evil. Whenever cir-

* For comparison with other species of the *Cossinæ* it may be stated that an example of *C. Centerensis*, ♂, has thirty-eight teeth in the anterior row of the tenth segment, and twenty teeth in the posterior row — the latter, in their entire range, occupying a transverse space equal to that of nine teeth of the anterior row. The teeth are black, shining, irregular in size, and are slightly bent upward over their base; their length and the distance between their tips exceeds their basal width.

cumstances favor it and enable it to multiply and become numerous in any section of our country, this little enemy, its mortal foe, will speedily be there to subdue and stamp it down. Thus nicely are the works of nature balanced, and no creature is permitted to usurp a place in her domain which does not belong to it.

The specimens of the parasite obtained by me at the time referred to in the above notice, were submitted to a friend who had made study of the group to which they belong, who believed them to be an undescribed species, and was only able to give them a doubtful generic reference. They were subsequently destroyed, and from that time until the present year (an interval of fourteen years), although I have continued to search for them I have been unable to obtain the species.

Its rediscovery by me the present year, and the determination of the species, lend additional interest to the notes upon it that I made at its first observation, at Utica, N. Y., in June, 1866, and I therefore transcribe them from my note-book:

I had collected a number of currant leaves upon which the currant saw-fly had deposited eggs, and was counting the eggs upon each to obtain the average number per leaf, when I noticed an occasional brown egg among them, appearing somewhat abnormal in shape. On placing them under a lens a resemblance to a pupal form was detected. I at once suspected the presence of the parasite for which we had been hoping. Although there seemed to be but the merest chance of discovering at large an insect so minute as this must necessarily be, I instituted a careful search of the currant bushes in the garden, and in a short time had the great gratification of seeing a minute speck moving among the eggs, which under my lens revealed a form which left scarce room for doubt of its parasitic character. During the day I detected several more of the kind upon the leaves containing egg-deposits, affording strong evidence of their relationship. A few days thereafter (perhaps a week), in a small phial in which I had placed some eggs that I suspected to have been parasitized, I had the delight of seeing several of the familiar forms of my currant-leaf acquaintances, and the ruptured pupa cases from which they had evidently escaped.

The following year (1867) there was a marked diminution in the number of currant-worms observed, and a corresponding increase in parasitized eggs. Many of the leaves had not been visited by the parasite, but of those that gave evidence of such visit, the work of destruction was almost complete, for of several leaves bearing each from thirty to forty eggs, all but five or six were transformed into parasitic pupæ.

In June, 1868, I was able to make, at Schoharie, N. Y., the following observations upon the oviposition of the parasite within the eggs of the currant saw-fly:

In a small phial in which had been placed some parasitized eggs of the saw-fly, a male and female parasite had emerged. That I might observe their actions I introduced a piece of currant-leaf having upon it some eggs which I had just seen deposited. No evidence was given that the

female was aware of the presence of the eggs, but after several minutes traveling around the glass, she moved upon the leaf, and in passing over and beneath it, seemed to meet with them accidentally. She paused, and then began a careful inspection, walking over them several times, and constantly palpating them with her antennæ. Then satisfied with her examination, she attached herself to one of the eggs, appressed the tip of her abdomen to it, and remained in this position motionless for the space of two and a half minutes, during which time an egg, doubtless, was inserted, although the pocket lens with which the observation was made did not disclose the fact. The motion of her antennæ then recommenced and I expected to see the operation just witnessed repeated upon another egg; but, to my surprise, she merely changed position — again applied the tip of her abdomen to a different part of the same egg, and remained at rest for about the same space of time as before. Three times I witnessed this performance, and it is, therefore, probable that three parasitic eggs were placed within the one of the currant-fly. Unfortunately an interruption prevented me from noticing if the remaining currant-fly eggs were similarly parasitized, and the number of eggs introduced in each; and much to my regret, the eggs were accidentally destroyed before my observations could be made upon their transmutation into parasitic pupæ. The pupa cases are dark brown, disclosing some of the outlines of the contained pupæ, somewhat flattened, broader than the original egg, but of about its length. The insect is apparently one of the *Chalcididæ*, having a broad head, long and elbowed antennæ, ovoid anterior wings, nearly veinless, beautifully iridescent, delicately fringed and haired; the posterior wings are almost linear; the abdomen is short, not reaching the tips of the wings.

This year (1868) is probably the first appearance of the parasite at Schoharie, as I could only discover about a dozen individuals. Its progress seems to be from west to east, corresponding with that of the currant-worm.

The rediscovery of the parasite the present year (1882) was made in my garden at Albany, upon a solitary currant bush growing there. The parasitized eggs were inclosed in a bottle, and in a few days the insects emerged. That I might multiply and aid in the distribution of an insect which had already shown its capability for usefulness, I visited another garden in the city to obtain eggs of the currant-fly for parasitization by my confined individuals. To my surprise, the parasite was here found in strong force, for in the examination of a long row of currant bushes containing many eggs, I could not find a single egg-bearing leaf which had not been visited and the destruction of the eggs insured. A large number of leaves were collected, each bearing perhaps from forty to fifty parasitized eggs. Reserving a few of these for study and for propagation, the remainder were made up in small parcels of about a half-dozen each, and mailed to entomological friends in various parts of the United States and Canada,* with

[* Canadian Entomologist, xiv, August, 1882, p. 147.]

the request that they be pinned upon currant bushes among the leaves where the currant-fly eggs were to be found. The introduction of parasites in this manner into localities where they had not previously occurred, has been shown to be practicable;* and in consideration of the great importance of parasitic aid in the destruction of our insect pests, I sincerely hope that my efforts to distribute this very efficient parasite may prove, from observations to be made hereafter, to have been successful.

Examples of the insect were sent by me to Mr. L. O. Howard, of the Department of Agriculture at Washington — a gentleman who has made special study of the family to which it pertains, viz., the *Chalcididæ*. He informs me that there is no doubt of its being the species described and named by Prof. C. V. Riley, in 1879 (Can. Entom., Sept. 1879, v. 11, pp. 161–162) as *Trichogramma pretiosa*, examples of which had been reared, at Washington, from eggs of the cotton-worm moth, *Aletia argillacea* Hübn., collected in Alabama. The description is reproduced, with additional information, in Prof. J. H. Comstock's Report upon Cotton Insects (Washington, 1879), p. 193. It has since been extensively reared from eggs of the same moth collected in Florida, by Mr. H. G. Hubbard. It has also been bred at the U. S. Department of Agriculture from eggs of an unknown Noctuid moth occurring on orange trees, and from *Aleyrodes*.

Prof. Riley, from some structural features, thought that it might be necessary to establish a new genus for this species and one or two closely allied ones, but Mr. Howard finds it to be a true *Trichogramma*, as at first referred.

Another species of the genus *T. minuta* Riley,† [shown in Fig. 68, and hardly to be distinguished in appearance from *T. pretiosa*], has been reared from the eggs of one of our common butterflies, of extensive distribution, *Limenitis disippus*. Parasitized examples of these eggs have given from four to six specimens of the minute creature, which, notwithstanding its specific name of *minuta*, exceeds in size the microscopic *T. pretiosa*, the latter being about 0.25 mm. in length.

FIG 68.—TRICHOGRAMMA MINUTA Riley: *a*, the fly in its natural position; *b*, a front wing; *c*, a hind wing; *d*, one of the legs; *e*, an antenna—all much enlarged.

In connection with the above notice of the egg-parasite of the currant-fly, it may be of interest to offer the following note of the oviposition of the currant-fly as observed by me, as its method has not to my knowledge been previously published.

June 7, 1868. *Nematus ventricosus* was seen to deposit thirty eggs upon a single currant-leaf within one hour. In the act of ovipositing, it curved the tip of its abdomen downward and forward, directing its ovipositor toward its head, in which position the end of the egg is seen to protrude

*Le Baron: *Third Annual Report on the Insects of Illinois*, 1873, *pp.* 200–202.

†*Third Annual Report on the Insects of Missouri*, 1871, *p.* 158, *fig.* 72.

and attach itself to the leaf-nervure, when the ovipositor is withdrawn, and the egg left in position. Moving backward a very little, another egg is similarly deposited, and in like manner the operation is continued, until the leaf has its assigned quota, or the supply of eggs is exhausted. The eggs produced their larvæ on June 14th.

(B.)

MISCELLANEOUS PUBLICATIONS OF THE ENTOMOLOGIST.

The following list comprises publications during the years 1882 and 1883, mainly in agricultural journals, most of which were in reply to inquiries made in relation to insects of economic importance:

Insects on Sweet Potato Vines. (Country Gentleman, for Feb. 23, 1882, xlvii, p. 149, c. 2–3 — 12 cm.)

The larvæ infesting sweet potato vines in St. Louis, Mo., are probably those of *Coptocycla aurichalchea*. Remarks upon the species and means of destruction, viz., application of Paris green and London purple.

Entomological — The Anatomy of the Mouth Parts and the Sucking Apparatus of some Diptera. (Country Gentleman, for February 23, 1882, xlvii, p. 151, c. 2–3 — 13 cm.)

The paper was prepared by Mr. George Dimmock, of Cambridge, Mass., as a dissertation for obtaining the philosophical doctorate at Leipsig University. In it the mouth-parts of *Culex*, *Bombylius*, *Eristalis*, and *Musca* are ably treated, of, and fully illustrated in four excellent plates. A résumé of previous publications on the subject is given.

Millions of Grasshoppers in Midwinter. (Albany Evening Journal, for February 25, 1882.)

Grasshoppers observed upon the surface of snow in Westchester county, New York, prove to be *Tragocephala viridifasciata*, "the green-striped locust" of Dr. Harris. This species has on different occasions appeared during warm days in winter, but has never been recorded as very injurious. Their early appearance at this time will cause the death of large numbers, and lessen the brood of the summer months.

A Winter Grasshopper — Tragocephala viridifasciata. (Country Gentleman, for March 9, 1882, xlvii, p. 189, c. 2 — 16 cm.)

Identification of the species, occurring in Genesee county, N. Y., in February — its history — is not often injurious — will probably be killed by frosts before its food appears.

The Hickory-Borer — Cyllene pictus (*Drury*). (Country Gentleman, for March 9, 1882, xlvii, p. 189, c. 2–3 — 8 cm.)

The species was for a long time confounded with the locust-borer, *C.*

robiniæ, but is separable by its longer and stouter antennæ and body behind tapering to a blunt point. The specimens received are in the pupal stage, showing in transparency, the yellow markings of the wing-covers. The larva is not as injurious to hickories as the locust-borer to locusts.

Apple-Leaf Bucculatrix. (Country Gentleman, for March 16, 1882, xlvii, p. 207, c. 1 — 5 cm.)

Small white-ribbed cocoons upon apple-tree bark, sent from Bergen county, N. J., are identified as those of *Bucculatrix pomifoliella* Clemens. The cocoons show a parasitic attack.

Insects that Injure Trees. (Country Gentleman, for April 20, 1882, xlvii, p. 313, c. 1–2 — 46 cm.)

Notice of Dr. Packard's "Insects Injurious to Forest and Shade Trees," being Bulletin No. 7 of the U. S. Entomological Commission. The volume presents a summary of what is known of insect injuries to our more useful trees. The notice remarks upon the importance of the preservation of our forests and attention given in Europe to the subject, and refers to the number of species of insects attacking trees in Europe and in the United States; it complains of the inferior character of some of the illustrations; mentions a revised edition contemplated.

The White Grub — Lachnosterna fusca (*Frohl.*). (Country Gentleman, for April 27, 1882, xlvii, p. 333, c. 2–3 — 34 cm.)

Belief expressed that the grubs destroying the roots of grass, will not injure potatoes on the same ground the following year. Methods given for their destruction, as shaking the beetles from the trees on which they congregate, rooting out the grubs by hogs, plowing up and exposing to birds, application of salt and other materials to render the food unpalatable to the grubs.

Mites in Timothy Fields. (Country Gentleman, for May 18, 1882, xlvii, p. 395, c. 1–2 — 19 cm.)

The little attention paid to the study of the Acarina in this country: reference to a few common species. This species pronounced by Dr. Hagen, of Cambridge, to be *Trombidium bicolor* Hermann, or very near to it. It is black with red legs — was observed April 28th at Concordville, Pa., on no other grass but timothy.

The Spring Canker-Worm — Anisopteryx vernata. (Country Gentleman, for May 18, 1882, xlvii, p. 393, c. 1–3 — 67 cm.)

Its distribution is from Maine to Texas, but it is usually quite local; efficiency of birds in destroying it; ascent of the tree trunks by the wingless moths should be prevented; may be done by bands of tarred cloth; Dr. Le Baron's band of rope with tin nailed upon it, and how it

operates; another trap (illustrated) is a band of tin suspended from a cloth bound to the trunk; when caterpillars are on the tree, beat them down on straw and burn them, or spray the leaves with Paris green water by a force-pump. Protection from the flat-headed apple-tree borer.

Leaf-mining Anthomyiidæ. (Canadian Entomologist, for May, 1882, xiv, pp. 96–7.) (Thirteenth Ann. Rept. of the Entomological Society of Ontario, for the year 1882. 1883, p. 29.)

Discovery of the first American species of leaf-mining *Anthomyiidæ*, mining beet-leaves at Middleburgh, N. Y., viz., *Chortophila floccosa* Macq., and two new species, to be described in the forthcoming Report of the N. Y. State Entomologist.

The Grain Aphis — Siphonophora avenæ (*Fitch*). (Country Gentleman, for June 22, 1882, xlvii, p. 493, c. 2–3 — 22 cm.)

Infesting wheat in Virginia; Dr. Fitch's notice of it in his 6th Report; its attack on the heads continued until the kernels harden; many of the examples are parasitized; *Aphis granaria* a synonym; attacks also oats, rye and barley.

The Apple-Tree Case-Bearer. (Country Gentleman, for July 6, 1882, xlvii, p. 533, c. 1–2 — 28 cm.)

The caterpillar, bearing its peculiar case, is sent from South Byron, N. Y.; natural history of the species, known as *Coleophora malivorella* Riley, given, with references to full notices of it; spraying with Paris green and London purple in early spring a good remedy for it. Directions for mailing injurious insects — should not be sent in paper boxes, permitting escape and propagation in new localities.

The Spring Canker-Worm — Anisopteryx vernata *Peck*. (Country Gentleman, for July 6, 1882, xlvii, p. 533, c. 2–3 — 26 cm.)

Abundance of the caterpillars in New Canaan, Ct., confined to two orchards. For means of destruction reference is made to notice in the C. G., of May 18. The pupæ, buried three or four inches deep beneath the tree, may be killed by breaking up the ground, or by turning swine in the orchards to root them up.

The Rose-Bug. (Country Gentleman, for July 6, 1882, xlvii, p. 534, c. 3 — 10 cm.)

Leaves stripped from cherry trees in Scarsdale, N. Y., by *Macrodactylus subspinosus*. The inquirer of name and habits is referred to C. G., of June 26. Sprinkling foliage with tansy water has been said to prevent its depredations. Paris green sprinkling would destroy it; shaking it from trees on sheets recommended.

The Seventeen-year Locust. The Ontario County Times, xxviii, for July 12, 1882, p. 3, c. 5 — 58 cm.)

Gives the seventeen-year and thirteen-year periodicity of Cicadas

and the years of their appearance during the present half-century; broods in the State of New York; injuries of the present brood upon the shore of Canandaigua lake, and preventives of future injuries.

A New Household Pest — Attagenus megatoma. (Country Gentleman, for July 20, 1882, xlvii, p. 567, c. 2–3 — 38 cm.)

Description of the beetle and of the larva; the larvæ occur beneath carpets upon which they feed; abundance of the beetle in Washington Park, Albany, on spiræas with *A. scrophulariæ;* are often found on windows within our houses; probably breeds also in hair-cloth furniture; does it injure cotton fabrics? benzine and kerosene for killing it; tympans and roofing-paper as preventives.

The Hessian Fly in Ohio. (Country Gentleman, for July 20, 1882, xlvii, p. 567, c. 3 — 14 cm.)

The wheat attacked by the second brood of the insect, of which the eggs were laid in May. The flies would emerge in July or August to attack the winter wheat; may possibly be a third brood. Protection of its parasites recommended; burning stubble would destroy the parasites. Wheat broken down by the attack should be cut low and reaped.

A Bark Beetle. (Country Gentleman, for August 3, 1882, xlvii, p. 605, c. 2–3 — 18 cm.)

Beetles found in Perrowville, Va., underneath the bark of apple-trees which show decay, and thought to be the cause, are *Hymenorus obscurus* (Say). They could not have caused the injury, but were probably drawn thither to feed upon the decaying material. None of the *Cistelidæ* are known to be obnoxious.

The Stalk-Borer. (Country Gentleman, for August 3, 1882, xlvii, p. 605, c. 3 — 15 cm.)

A caterpillar, injurious to the potato crop near Syracuse, N. Y., is *Gortyna nitela* Guen.; often destructive to corn; cannot be reached by external applications; may be removed by cutting into the stem of the potato; burning the vines for killing the pupæ remaining in them recommended.

Wire-Worms infesting Potato Vines. (Country Gentleman, for August 10, 1882, p. 625, c. 2 — 18 cm.)

Reported from Scarsdale, N. Y., as first boring into the vines near the ground, and later into the tubers; belong to the *Elateridæ* but the species unknown; habits of the beetles; crops attacked by the larvæ; no effectual remedy for them known; reference to Dr. Fitch's paper on wire-worms in his 11th Annual Report.

The Horn-Tail Borer — Tremex Columba (*Linn.*). (Country Gentleman, for August 10, 1882, xlvii, p. 625, c. 2–3 — 26 cm.)

A maple tree at Poughkeepsie, N. Y., shows fifty or more holes in

the trunk bored by this insect; how the egg is inserted; operations of the larva; the oak, elm and the sycamore also attacked; *Glycobius speciosus* more injurious to maples; *Rhyssa lunator* and *R. atrata* associated with the *Tremex* as parasitic upon it.

The Spotted Horn-Bug. (Country Gentleman, for August 17, 1882, xlvii, p. 645, c. 2 — 24 cm.)

A beetle with a very offensive odor, injuring the foliage of ash trees in Perrowville, Va., is the *Dynastes Tityus*. The odor of the specimens sent is so intolerable that they cannot be kept within doors. The beetle is described; the larva feeds upon decaying trees. The insect is rare in Pennsylvania, and is not known to occur in New York. The depredations of the beetle upon the foliage of the various trees which it attacks, may be arrested by showering with Paris green or London purple.

Mites infesting a Poultry House. (Country Gentleman, for August 17, 1882, xlvii, p. 645, c. 2–3 — 13 cm.)

The species is not recognized — may be the same that infests the nests of sitting-hens. They may be killed with kerosene in water applied with a syringe or force-pump to every part of the hen-house. If occurring in a close building, fumigation with sulphur would be efficient.

A New Worm in Apples. (Country Gentleman, for September 21, 1882, xlvii, p. 745, c. 2–3 — 21 cm.)

A white worm in early apples reducing the interior to pulp while the outside is fair, in Ascutneyville, Vt.; is not determinable from the brief statement sent; may perhaps be the *Sciari mali;* operations of this species as given by Dr. Fitch; its larva and imago described. [Is probably *Trypeta pomonella.*]

The Black Blister Beetle — Epicauta Pennsylvanica (*DeGeer*). (Country Gentleman, for September 21, 1882, xlvii p. 745, c. 3 — 15 cm.)

The beetle injures carrots and cabbages in Baltimore, Md., which have not previously been recorded as among its food-plants; habits of the beetle; for destroying them beat them into a vessel with kerosene and water or dust with pyrethrum, as was successfully done at Ithaca, N. Y., to large numbers defoliating a passion-vine.

The Hag-Moth Caterpillar. (Country Gentleman, for September 21, 1882, xlvii, p. 745, c. 3–4 — 20 cm.)

The larvæ of *Phobetron pithecium* (Sm.-Abb.), feeding on a crab-apple tree, described; its cocoon and its appendages; the larva found also on cherry-trees; its power of stinging; unreasonable fear of most caterpillars.

A New Apple Insect — Amphidasys cognataria *Guen.* (Country Gentleman, for October 5, 1882, xlvii, p. 785, c. 2–3 — 34 cm.)

Injuring apple-trees in Chelsea, Wis.; description of larva; now first

noticed on apple; other food-plants; characteristics of the *Geometridæ;* will probably not prove very injurious; may be removed from trees by jarring.

Destructive Elm-leaf Beetle — Galerucella xanthomelæna *Schrank.* (Country Gentleman, for October 12, 1882, xlvii, p. 805, c. 1–2 — 38 cm.)

Identified from leaf injuries in Bound Brook, N. J. Depredations in N. Y., N. J. and southward; its appearance. Spraying with Paris green and water, jarring and boxing about the base of trees recommended for its destruction.

A New Principle in Protection from Insect Attack. [Read before the Western N. Y. Horticultural Society, at its Annual Meeting, January 25, 1882.] (Proceed. Western N. Y. Horticultural Society, for 1882, pp. 52–66. Separate, with one-half title p. cover, pp. 15 [March, 1882.])

Preventives preferable to remedies; strongly odorous substances, available for the prevention of egg-deposit; insects guided in oviposition by the sense of smell rather than by sight; acuteness of this sense in man and animals; the probable location of smelling organs in insects; instances of attraction, sexual and otherwise, by odors; scent-organs and their importance; counterodorants and how they may prevent egg-deposit; the results of protection by this method; the aim of practical entomology.

A Rose Leaf Insect. (Country Gentleman, for March 1, 1883, xlviii, p. 169, c. 2 — 17 cm.)

A caterpillar feeding on rose leaves in a green-house in Westchester Co., N. Y., identified as *Penthina nimbatana* (Clem.). The caterpillar briefly described, its habits mentioned, and method proposed for its destruction.

Of Interest to Flower Growers — A New Enemy Found. (Troy Daily Times, for April 2, 1883.)

Discovery of a species of caterpillar, feeding in the green-house of Dr. R. H. Sabin, Troy, N. Y., upon heliotrope, geranium, wandering jew (*Tradescantia*), etc.; features of the caterpillar and cocoon; is probably *Plusia dyaus* Grote, although seemingly differing somewhat from that species.

The Bean Weevil. (Country Gentleman, for April 19, 1883, xlviii, p. 317, c. 3 — 16 cm.)

Identification of *Bruchus fabæ* Riley, from Delhi, N. Y. For history of the species, reference is made to C. G. of December 8, 1881. The apartments where they are found at this season should be searched for the living individuals, which should be killed; and all beans should be kept during the winter in tight vessels or bags to prevent the escape and distribution of the beetle.

Thousand-Legged Worms in a Nursery — Julus cœruleocinctus *Wood.* (Country Gentleman, for May 24, 1883, xlviii, p. 421, c. 2 — 26 cm.)

Identification of the species sent from Geneva, N. Y., May 10th. How they differ from "wire-worms" with which they are often confounded. *Julidæ* live usually on decaying vegetables, but this species feeds also on living vegetables, often on potatoes. It will probably not injure apple-tree roots, being more of a surface feeder, coming abroad at night, when it may be trapped by means mentioned. Gas-lime recommended for its destruction. The eggs, the young and habits are referred to.

Curious Ichneumon Cocoons. (Country Gentleman, for June 14, 1883, xlviii, p. 481, c. 2–3 — 35 cm.)

Cocoons of *Apanteles congregatus* (Say) occur upon an apple-tree, in Brooklyn, N. Y. The peculiar cluster is described; the habits of the Microgasters given; and the importance of protecting, rather than destroying similar parasitic cocoons.

On an Egg-parasite of the Currant Saw-fly, *Nematus ventricosus*. (Psyche, for May and June, 1883, iv, pp. 48–51.)

First discovered by the writer in the year 1866, at Utica, N. Y. Its oviposition described. Rediscovered in 1882, at Albany, N. Y. Proves to be *Trichogramma pretiosa*, described by Riley in 1879, from eggs of the cotton-worm moth. Parasitized eggs of the Nematus have been distributed to other States and Canada for colonization. Notice of the oviposition of *Nematus ventricosus* as observed.

Rearing Lepidoptera. (Psyche, for May and June, 1883, iv, p. 53 — 13 cm.)

Notices the lepidopterological studies and especially the larval collections, and rearing from the egg, of Mr. S. L. Elliot, of New York city. His success in rearing lepidoptera has not been surpassed by any one in the United States.

Codling Moth of the Apple. (Country Gentleman, for June 28, 1883, xlviii, p. 521, c. 2 — 11 cm.)

Numerous codling-moths (*Carpocapsa pomonella*) received from the Rochester, N. Y. nurseries of Mr. Barry, with report of injuries, indicating an increase of this apple-pest in the western part of the State. The threatened increase should be earnestly combatted by the most approved methods. Paper bands around the trees and showering with Paris green in water early in the season, recommended.

An Interesting Bug. (Country Gentleman, for June 28, 1883, xlviii, p. 521, c. 2–3 — 33 cm.)

Insects sent from Burlington, N. J., for identification and habits

are larvæ (1st stage) of the *Reduviina*, which cannot be positively identified, but may be the "wheel-bug," *Prionotus cristatus* (Linn.). The eggs received with them are described and also the larvæ. The species deserves protection from its habit of preying on other destructive insects. Their habits are briefly given, together with an account of a two hours' contest observed between one of the larvæ and a pupa of *Penthina nimbatana*. The result of a wound inflicted by one of these insects is stated.

Book Notice. (Psyche, for May and June, 1883, iv, p. 53 — 11 cm.)

Notices the volume on the Insects of our Fruit-Trees, by Mr. William Saunders, as soon to be published.

The Maple-Tree Scale-Insect — Lecanium innumerabilis *Rathvon*. (Country Gentleman, for July 5, 1883, xlviii, p. 541, c. 3–4 — 66 cm.)

The scales received from Parkersburg, W. Va., June 18th, with inquiries. They belong to the *Coccidæ;* history of this species given; the different trees attacked by it; reference to papers treating of it. Among the remedies for the insect, are mentioned, scraping and scrubbing the bark, cutting down and burning badly infested trees, spraying with a whale-oil soap solution or with a kerosene emulsion. Directions for preparing the latter are given. The literature of the species is presented.

The Black Long-Sting — Rhyssa atrata (*Fabr.*). (Country Gentleman, for July 12, 1883, xlviii, p. 561, c. 2–3 — 28 cm.)

Insect from Athens, N. Y., identified as *Rhyssa atrata*. Its principal features are given. The habits of the Rhyssa of ovipositing in the larvæ of *Tremex Columba* as usually given, has recently been questioned by Mr. Clarkson, in the *Canadian Entomologist* — very properly so, it is thought. Another use for the long ovipositor is suggested, based upon an occurrence noticed by the writer.

Hairworm — Vanessa — Alaus — Gordius and Mermis. (Country Gentleman, for July 19, 1883, xlviii, p. 581, c. 1–2 — 52 cm.)

A Gordius from Bainbridge, N. Y., identified. The popular superstition of the transformation of a horse-hair into the hairworm is referred to. The general character and modes of occurrence of *Gordius* and *Mermis* are given, and the life-history, in brief, of the former. *Vanessa antiopa*, sent as injurious to elms is characterized in its larval and butterfly stage. *Alaus oculatus* is briefly described and some of its habits given.

An Oak Moth — Anisota senatoria (*Sm.-Abb.*). (Country Gentleman, for July 26, 1883, xlviii, p. 601, c. 3 — 16 cm.)

Received from Roslyn, N. Y. With its name, the principal features of the moth and the caterpillar are given. Its abundance at Karner, N. Y., is stated, together with its several changes, and mention of congeneric species, less injurious.

Captures of Feniseca Tarquinius (*Fabr.*). (Psyche, iv, for July–August, 1883, p. 75 — 13 cm.)

A number of examples of the species collected at Keene Valley, N. Y., about alders. Had also been taken in one example at Center, N.Y., by Mr. O. von Meske, but never before by the writer.

[Platygaster larva destroying galls of Cecidomyia salicis-batatus.] (Psyche, iv, for July–August, 1883, p. 79 — 7 cm.)

Reference to Prof. D. S. Kellicott's observations on the above, as published in the Bulletin of the Buffalo Naturalists' Field Club, for March, 1883.

[Collecting Cut-worms at evening with a light.] (Psyche, iv, for July–August, 1883, p. 80 — 10 cm.)

Notice of collections made by Mrs. Mary Treat, about dusk in the evening, from flower buds of phlox, and from beneath the ground around the roots and from the branches of a plum-tree.

A Grape Pest — Procris Americana. (Country Gentleman, for August 2, 1883, xlviii, p. 621, c. 2–3 — 18 cm.)

The insect steadily increasing in Champaign county, Ohio. The caterpillar and moth are described, and the transformations given. The best remedy for it is to look for the skeletonized leaves at the commencement of the attack, to pinch them off and crush the larvæ.

Potter-wasp Cells on Grape Leaves — Eumenes fraternus *Say*. (Country Gentleman, for August 9, 1883, xlviii, p. 641, c. 4 — 22 cm.)

Sent from Sandy Hill, N. Y., for determination. The external appearance of the cells described, and also the interior, and the contained pupa; is probably the above-named species, which is common in Eastern United States. Remarks upon the structure of the cells; they are crowded with caterpillars for the larval food; the larva matures in about a month. Reference to figures in Saunder's "Insects Injurious to Fruits," page 70.

The Frenching of Corn. (Country Gentleman, for August 16, 1883, xlviii, p. 661, c. 4 — 28 cm.)

"Frenching" results from various causes — from disease as well as insect attack. Young stalks of "frenched" corn received from Rock Hall, Md., show numerous perforations made undoubtedly by a *Sphenophorus*, and probably by *S. sculptilis*. The appearance, habits, distribution, and life-history, in part, of the beetle, is given, and the best remedies for it.

The Striped Squash Beetle. (Country Gentleman, for August 23, 1883, xlviii, p. 681, c. 2 — 15 cm.)

Gives the appearance and habits of the larva of *Diabrotica vittata*

(Fabr.), and recommends the application of carbolic acid and water (1 part to 100) about the stems to prevent attack. If the larvæ are eating into the stem, sand saturated with kerosene oil should be spread around it, — the oil to be gradually carried into the soil to kill the larvæ.

The Carpet Bug, Anthrenus scrophulariæ. (Country Gentleman, for August 23, 1883, xlviii, p. 681, c. 2–3 — 16 cm.)

The larva reported as injuring linen and silk goods, but its feeding upon these articles has not been established, and is doubted. Benzine is named as the best remedy for its attack, and coal-tar roofing-paper, and "carbolized paper" as preventives.

The Pine Emperor Moth. (Country Gentleman, for September 27, 1883, xlviii, p. 781, c. 2–3 — 24 cm.)

The larva of *Eacles imperialis* (Drury), is sent for identification from New Jersey, where it was found feeding upon plum. It had not been hitherto recorded upon this food-plant. Its food-plants are mentioned, the caterpillar described, its habits, transformations, and the principal features of the moth given. Reference is made to further information of the species.

Saw-Fly Larvæ on Quince. (Country Gentleman, for October 4, 1883, xlviii, p. 801, c. 2 — 12 cm.)

Quince leaves in Erie, Pa., are badly eaten by the larva of a saw-fly feeding on the upper surface of the leaf. The species is not identified. A description of it is given. The larva of *Vanessa antiopa*, feeding on elm, and *Adalia bipunctata*, found on quince, are identified.

Bark Louse on Willow. (Country Gentleman, for October 4, 1883, xlviii, p. 801, c. 2–3 — 22 cm.)

The apple-tree bark-louse is found incrusting a stem of Kilmarnock willow, from Ansonia, Conn. Other plants upon which it is known to occur in addition to apple, are named. The species belongs to *Mytilaspis*, and according to Prof. Comstock, is identical with *pomorum* of Bouché. As remedies, scouring with soap-suds and a stiff brush, and showering with a kerosene emulsion are recommended.

The Chinch-bug in Northern New York. (Albany Argus, for October 10, 1883, p. 3, c. 2–3 — 90 cm. Watertown Daily Times, for October 12, 1883 [the same article copied]. Country Gentleman, for October 18, 1883, p. 841, c 2–4. [the same copied nearly entire].)

Following a letter from Mr. M. H. Smith, of Redwood, Jefferson Co., N. Y., giving an account of the discovery of the insect and the injuries committed, the report of the writer is given, after his visit to the infested locality, embracing the following heads: The insect identified — appearance of the insect — observations upon the attack — just cause for alarm — persistence of the attack — importance of arresting the attack — remedial measures recommended.

A New Enemy to the Farm. (Albany Argus, for October 10, 1883, p. 4, c. 3 — 30 cm.)

A recapitulation of the preceding paper, slightly altered from MS. to serve as an editorial.

The Chinch-bug in New York. (Science, for October 19, 1883, ii, p. 540 — 16 cm.)

Its detection in large numbers in St. Lawrence Co., N. Y., where it is proving destructive to timothy-grass. Its rapid increase noticed, notwithstanding that this and the past year have been unusually wet ones in Northern N. York. Its threatened spread is occasioning great alarm, but it is hoped that it may be arrested by the general use of kerosene oil emulsified.

Directions for Arresting the Chinch-bug Invasion of Northern New York. (Circular No. 1 — October, 1883. New York State Museum of Natural History: Department of Entomology, 8vo., 3 pp., fig.)

Narrates the features of the attack in St. Lawrence Co., N.Y., refers to the importance of arresting its extension, and recommends for the purpose: 1. Examination for detecting the commencement of the attack: 2. Burning, as directed; 3. Plowing as directed; 4. Harrowing and rolling; 5. When plowing is not practicable, use gas-lime. The above to be done at once. Further directions for attacking the spring brood are promised herafter.

The Mole-Cricket. (Country Gentleman, for October 25, 1883, xlviii, p. 861, c. 2 — 20 cm.)

The insect sent as being quite plentiful at Woodbury, N. J., is identified as *Gryllotalpa borealis* Burm., and described. Its method of excavating its galleries are narrated and the injuries committed by it upon grass and garden vegetables. Hot water poured into the burrows of the insects will kill them when they become too abundant. In Europe they are sometimes trapped in manure pits. The ability of the insect to swim and dive readily in the water, as communicated, had not been previously recorded.

The Ant Lion. (Country Gentleman, for November 1, 1883, xlviii, p. 881, c. 1–2 — 33 cm.)

Larva of *Myrmeleon* sp.? received from Falls Church, Va. Appearance of the ant-lion, structure, the pitfall constructed by it, and its operations with its prey. Means by which the larvæ may be collected, with remarks upon the winged insect.

New Corn Pest — Megilla maculata. (Country Gentleman, for November 22, 1883, xlviii, p. 941, c. 1, 2 — 48 cm.)

The *Coccinellidæ*, long regarded as wholly carnivorous, have lately

been found to be partly herbivorous. Prof. Forbes has shown that more than one-half the food of some species is vegetable. In 1874, *M. maculata* was reported as injuring corn in the milk. This habit was confirmed by Mr. Pergande in 1882. The beetles now sent from Fairfield, Conn., by Mr. Sturges, taken by him from within the kernels of corn, are the same species. The nature of the injury to corn is described, also the insect itself, and a cause for its attack suggested.

The Apple-Maggot — Trypeta pomonella. (Bulletin No. LXXV. N. Y. Agricultural Experiment Station. December 29, 1883 — 110 cm.)

An attack upon apples in Brandon, Vt., by which they are completely "honey-combed," is stated to be probably by *Trypeta pomonella*. The habits of the larva, its description, that of the fly, life-history of the species, its ravages and distribution, and remedial measures against it are given. Information (points stated) still needed of these attacks. *Sciari mali* should not be confounded with the species.

(C.)

The following valuable paper of Dr. Fitch upon some rare insects of the State of New York, was almost lost in publication, from the small number of copies published of the volume in which it appeared, and the difficulty of obtaining access to it. A few copies of the paper were also issued as separates with, with pagination of 1–11, but they are to be found to-day in hardly any of our public libraries, or even in private hands. Its republication, therefore, at this time, cannot fail of being acceptable to entomologists.

[*From the American Quarterly Journal of Agriculture and Science, May*, 1847, *vol. v, pp.* 274–284.]

WINTER INSECTS OF EASTERN NEW YORK.

BY ASA FITCH, M. D.

It is the object of the following paper, to describe those insects of Eastern New York, which occur in their perfect state in the winter, and are peculiar to that season and the early part of spring. They are objects of curiosity, as coming forth to our view in full maturity and vigor, at that time in the year when almost every other member of the animal and vegetable kingdoms is reposing in torpidity under the chilling influence of solstitial cold. In an economical aspect, they possess but little importance, their period of life being limited to that season when the field furnishes no herbage, the garden no flowers, and the orchard no fruits, on which they can prey. They are chiefly interesting, therefore, merely as objects of scientific research — as forming integral parts of that vast array of animated beings, with which the Father of Life has populated our world, and rendered it vocal with his praise.

Hence it is to the scientific rather than the agricultural reader, that the following pages are addressed. To him they will be sufficiently intelligible, without such illustrations as have accompanied our previous contributions to this Journal.

A few words respecting the analogies of the two first species here described, may not be devoid of interest to the general reader. A small insect, destitute of wings, and bearing some resemblance to a flea in its general aspect, is found in the winter season, upon the snow in the northern part of Europe, and also occurs upon the Alps and the Hartz mountains. It has been known for nearly a century, and from its singularly anomalous characters, naturalists have been much perplexed to determine in which particular family of the insect tribes it might with the most propriety be placed. Linnæus was the first to classify and name it. He regarded it as

possessing more analogies with the species associated in his genus *Panorpa*, [*] than with any other insects, and accordingly arranged it with them, bestowing upon it the specific name *hyemalis*. But, inasmuch as it differed from the Panorpidæ in some prominent particulars, such as possessing the faculty of leaping, and being furnished with an ovipositor similar to many grasshoppers and crickets, Panzer, at a subsequent day, placed it under the genus *Gryllus*. More recent naturalists, however, have concurred in the propriety of the location originally given by Linnæus, and to obviate, in some degree, the incongruity of its situation, Latreille was induced to construct for it an independent genus, placed beside Panorpa, to which genus he gave the name *Boreus*. The *hyemalis* has remained to this day the sole species of this genus, no other insect having similar characters, having been discovered in any part of the world. Two years since, in the month of March, searching carefully upon the melting snow, to find if possible in this vicinity, a rare and singular insect which has been lately discovered in Canada — the *Chionea valga*, a fly destitute of wings — though unsuccessful, my labors were rewarded with an equally acceptable return, an insect cogeneric with the curious *Boreus hyemalis* of Europe. Since that time, I have met with numerous specimens, and have also found in the same situations, several individuals of a third species pertaining to the same genus. From these specimens I draw the following detailed characters of the

Genus BOREUS, *Latreille.*

Polished and shining. *Head* sunk into the thorax to the eyes, which are prominent; ocelli wanting. *Rostrum* long-conical, twice or thrice as long as the head from which it gradually tapers, projecting downwards at right angles with the body, or more or less inclined backwards under the breast, its front side clothed with minute hairs. Maxillary *palpi* reaching beyond the tip of the beak; terminal joint longest and slightly thicker than the others, long ovate; basal joints cylindrical, half as long as they are broad. *Antennæ* inserted in the middle of the front, their bases nearer to the margin of the eyes than to each other, reaching half the length of the abdomen in the females and to its tip in the males, thickly set with very short minute hairs; filiform, hardly thicker toward their tips, composed of twenty-three joints; two basal joints thickest, the first subcylindric, the second obovate; succeeding joints short-cylindric, compact; terminal joint ovate. *Thorax* cylindrical, scarcely as broad as the head. *Wings, in the males*, rudimentary and not adapted for flying. Upper pair represented by two coriaceous pseud-elytral scales which reach rather more than half the length of the abdomen; these are broadest at their base and gradually taper to an acute point, the length being over four times as great as the breadth; they are very convex above and concave on their under sides, and thus when detached, bear some resemblance to

[* Through a typographical error, the genus is given as *Purpano.*]

the chaff-scale or glume of a small kernel of grain; the apex is armed with a straight thorn-like spine which is directed backwards and downwards; the inner margin is studded with a row of small teeth, which are longer and more distinct toward the apex of the pseud-elytron; these teeth are inclined backwards, and at their points they are strongly curved in the same direction; both the outer and inner margins are minutely ciliated with short hairs. The under wings are represented on each side by a curved bristle which lies under the pseud-elytron and within its concavity; it scarcely exceeds the pseud-elytron in length, is slightly dilated at its base, curves inwards and downwards, is almost hooked at its tip, and gives off an occasional short hair. *In the female* the wings are entirely wanting, the only vestiges of them being two minute scales occupying the place of the upper pair; these scales are circular and scarcely the hundredth part of an inch in diameter in *B. nivoriundus*, slightly elongated and a third smaller in *B. brumalis;* they are convex above and concave beneath, and attached to the thorax by a short broad pedicel; their edges are ciliated with minute hairs: their upper surface is also thickly set with very short, erect hairs, and is crossed by an elevated rib or slight keel. *Legs* long, particularly the posterior pair, the length of which exceeds that of the body; their several joints cylindric and densely clothed with short minute hairs; the first tarsal joint half as long as the tibia, the four remaining joints successively shorter, terminated by two small, slender, simple hooks. *Abdomen* oval, depressed when exsiccated, the segments distinctly marked by strongly impressed transverse lines, and clothed with fine appressed hairs; in the males it is nearly cylindrical, but little broader than the head, truncated as it were at its apex and turned upwards; tip of the last segment furnished with two stout sharp-pointed hooks, each with an acute tooth in the middle of its inner edge, and pilose along its outer edge; these hooks are susceptible of being extended in a line with the body, but are commonly strongly recurved upon the back shutting down upon and grasping a small scutel-like process which projects upwards at the base of this segment. They are thus recurved in coition, the male organ being exserted from between their bases. *Ovipositor* robust, about half as long as the abdomen of the female, projecting backwards in a line with the body, composed of a three-jointed semicylindrical piece above, and two ligulate valves below; the latter have their lower edges held in contact, thus forming a little gutter, and on the under-side toward their tips they are finely serrated; of the upper piece, the middle joint is much the longest, and is lined beneath on its concave side with a membrane which becomes distended with fluid when the abdomen is pressed upon; the short terminal joint is susceptible of being inclined obliquely downwards, thus, at least partially, closing the end of the ovipositor; the upper and lower pieces are widely separated in coition to enable the tip of the male abdomen to approximate that of the female.

1. BOREUS NIVORIUNDUS. *The Snow-born Boreus.*

Shining black or brownish-black; rudimentary wings, thorax above,

with the rostrum and ovipositor excepting their tips, fulvous; legs dull fulvous.

Length, male twelve-hundredths of an inch; female, 0.15, or including the ovipositor, 0.18.

Head black, highly polished, glabrous. Eyes black. Rostrum fulvous and feebly diaphanous, the mouth and palpi black. Antennæ black, two basal joints sometimes fulvous-brown. *Thorax* black on the sides, above varying in color from dull fulvous to cinnamon-yellow, the basal half of the prothorax being black. *Abdomen* black, brownish black, or dull fulvous-brown; terminal segment fulvous or cinnamon-yellow, its hooks in the males cinnamon-yellow, their tips and teeth black and highly polished; ovipositor in the females diaphanous, fulvous, sometimes inclining to rufous, black at its tip. Rudimentary *wings* cinnamon-yellow; in the males often of a duller hue toward their tips; rudimentary inferior wings in the males of the same color as the superior. *Legs* lurid-yellow and sub-diaphanous, with a slender black annulus at each of their articulations; three last joints of the tarsi wholly black.

Closely allied to the *B. hyemalis*, which, however, appears from Rambur's Neuroptera, the Penny Cyclopædia, and the beautiful colored figure in Westwood's Introduction, the only definite authorities to which I am able to refer, to have the basal two-thirds of the antennæ of a russet color, and the rudimentary wings and the legs strongly inclining to red. Our species presents no tinge of rufous, except sometimes in the ovipositor; and the antennæ, black to their bases, is a decided distinctive mark.

This insect is by no means rare, being found upon the snow in forests in warm days, so early as December, and becoming more common as the season advances. I have met with it the most plentiful in April, when there has been a fall of snow in the night, succeeded by a warm forenoon of bright sunshine. Appearing so suddenly, in numbers, upon the clean, dazzling white surface thus spread over the earth, at the first thought it seems to be literally bred from the snow. I have not yet searched for it in the moss of tree-trunks, but doubt not that like the European insect, ours will also occur in this situation. When observed upon the snow, it is almost always stationary; and when approached by the hand, it commonly makes a leap, to the distance of a few inches only, its saltatory powers appearing but feeble.

2. Boreus brumalis. *The Mid-winter Boreus.*

Polished deep black-green; legs, antennæ, rostrum, and ovipositor black; rudimentary wings brownish-black.

Length, male 0.10; female 0.12, or including the ovipositor 0.15.

This species presents no very obvious characters beyond those already given. Its body is highly polished, shining even with a metallic lustre whilst the eyes, antennæ, rostrum, and legs, reflect the light but feebly. The ovipositor is pure black, but equally splendent with the black-green

abdomen. The scales which occupy the place of the wings in the females are but faintly perceptible, appearing like two minute greyish-black spots on the thorax. In the living insect, there is a light fulvous vitta, obvious to the naked eye, along each side of the abdomen, at the lateral suture; this is frequently obliterated or but imperfectly discernible in the dried specimen.

So far as I have at present observed, this appears abroad earlier in the season, and in colder weather than the preceding, though occasionally found associated with it on the last snows that fall in the spring. It is much less common than the other.

3. PERLA NIVICOLA. [*] *The Small "Snow-fly."*

Black; wings grey, unclouded, a third shorter than the abdomen in the males, a third longer in the females.

Length 0.20, wings expand 0.45; males smaller.

Head shining, clothed with very short, fine hairs. Palpi brownish-black, sub-diaphanous. Antennæ reaching half the length of the wings, black, setaceous, about thirty-jointed; joints obconic, basal one largest. *Prothorax* flattened, its margins more smooth and shining, its disk rugulose, with a few shallow impressions; an impressed transverse line near the base and another near the apex. *Abdomen* shining, with a broad pale fulvous dorsal vitta which does not extend on to the two last segments; venter with a tint of obscure pallid at base. Setæ as long as the abdomen, black, setaceous, clothed with short whitish hairs; joints from thirteen to about eighteen in number, obconic, gradually shorter toward the base. *Legs* black, joints cylindric. Tibiæ obscure pale brown except at the tips, subdiaphanous, grooved longitudinally. Tarsi, basal joint longest, second joint very short. *Wings* reaching half the length of the setæ, finely ciliated at their tips and along their inner margins; gray, diaphanous, immaculate; nervures black, robust, and very strongly marked, particularly on the upper pair which have five closed cells in the disk. The male is smaller, with the wings reaching but two-thirds the length of the abdomen, its palpi and entire tergum black, and the tibiæ darker than in the female.

On warm days in the latter half of winter this species may be observed crawling with hurried steps upon the snow. It becomes most numerous about the time the snow finally disappears, and is then often seen on shrubs, fences, and buildings, and not unfrequently finds its way into our houses. It is extremely common, occurring most abundantly in the vicinity of streams of water, in which element the previous stages of its existence are passed. When first excluded from its pupa state, it is of a pale yellowish color, but gradually changes to black, this change commencing upon the thorax. Copulation occurs immediately after the female comes from the pupa state.

[* Is *Capnia pygmæa* (Burm.) Pictet: Hist. Nat. Ins. Neurop., 1841, p. 324, pl. 40, figs. 1-3.]

4. NEMOURA NIVALIS. *The Large "Snow-fly." The "Shad-fly."*

Black; wings griseous, faintly banded, double the length of the abdomen.

Length, males somewhat under, females over half an inch; wings expand about an inch.

Head covered with minute whitish hairs, which are longer and more obvious beneath the bases of the antennæ and around the mouth. Vertex with an obtusely impressed transverse line immediately back of the two posterior stemmata, and a longitudinal medial one, reaching from the former to the neck. Antennæ black, clothed with very short minute hairs, slender, setaceous, as long as to the tips of the wings in the males and somewhat shorter in the females, composed of about sixty joints; basal joint short-cylindrical, its diameter double that of the third and following joints; second joint intermediate between the first and third in diameter, its length and breadth about equal; the remaining joints obconic, gradually diminishing in diameter and increasing in length toward the tips. Palpi clothed with very short, minute hairs, black; basal joints of the maxillaries lurid and slightly diaphanous, penultimate joint rather the shortest and obconic, the joint preceding it longest and obconic, the terminal joint oval, and scarcely as thick as the others. *Prothorax* square, in the females scarcely broader than it is long, somewhat narrower anteriorly, posterior angles rounded, all the margins slightly and obtusely elevated, the posterior one more obviously so, often with a dull fulvous spot at the base, or with this color spread over the posterior part of the raised margin, and more rarely a similar spot at the middle of the apex; disk sometimes showing an impressed transverse line, and a longitudinal dorsal stria. Exposed portion of the *mesothorax* much elevated above the plane of the prothorax, forming a transverse ridge between the bases of the wings; clothed with short hairs; often with traces of dull fulvous around the wing-sockets; the portion of the mesothorax and metathorax covered by the wings smooth and shining. *Abdomen* reaching but half the length of the wings; sutures of the tergum in the female more or less widely marked with dull rufous; tip, in the female only, furnished with two short, filiform setæ, scarcely equalling in length the segment to which they are attached; setæ pale lurid, sub-diaphanous, hairy, composed of about eight joints. Each segment of the venter with two transverse impressions, one situated toward each posterior angle. Male organ exserted, forming a conical lurid point near the base of the last ventral segment. *Femurs* cylindrical, black, clothed with white hairs, which are longer and more distinct in the females, inner side with a narrow deep groove which is dilated toward the apex. *Tibiæ* cylindrical, about half the diameter of the femurs, grooved, lurid-brown, diaphanous, the ends and inner sides black; apex slightly incurved and armed with two short spines on the inside. *Tarsi* black, composed of three joints, whereof the middle one is slightly shorter; two claws and an intervening pellet at the tips. *Wings* griseous, when closed showing faintly two paler bands, one

near the middle and the other back of it; edges ciliated with fine, short hairs. Upon wings diaphanous, gray, faintly marked with a darker cloud back of the middle, and another occupying the tips, but not reaching to the edge, these clouds becoming wholly obliterated in cabinet specimens; nervures black. Lower wings gray, sub-hyaline, nervures black.

When recently excluded from the pupa, the abdomen, except at its tip, is of a dull rufous color; this gradually becomes darker, and finally pure black. For a time after the venter has become wholly black the tergum continues dull rufous with a black band on each segment, which band does not reach the lateral margins. These bands increase in size, and at length the whole tergum is overspread with pure black.

It is not uncommon to meet with specimens of this and the preceding species, infested with a minute parasite of the family *Acaridæ*. These parasites are of a bright vermillion-red color, and fix themselves, one or more, at the sutures of the tergum, not quitting their hold after the death of the insect, unless disturbed.

This species begins to appear, soon after the small Snow-fly is first met with. It occurs in the same situations, is nearly as abundant, and remains for a time after that has disappeared. One of the purposes served by these prolific insects in the economy of nature, doubtless is, to supply with food the fish of our streams, at this early period of the year. The larger of these species continuing to be abundant when the shad first come into our rivers, has evidently received one of its popular designations in allusion to this fact.

We regard this as the American analogue of the European *Nemoura nebulosa*, Linn. But from several points in the extended description of that species given by M. Ramber (*Suites à Buffon, Insectes Nevroptères*, Paris, 1842), it is quite obvious that ours is a distinct species.

5. Culex hyemalis. [*] *The Winter "Musketoe."*

Thorax cinereous, with a broad black vitta on each side; extreme tips of the wings and two spots on their anterior margins black, with two intervening sericeous yellowish white spots.

Length 0.22; to the tips of the wings 0.28, or including the beak 0.39.

Head cinereous-pubescent, occiput black-pubescent. Proboscis black, its apex cinereous. Palpi black, the tips varied with gray. Antennæ black, tips brown. *Thorax* cinereous-pubescent, with a broad rufous-black vitta on each side, passing above the wing-sockets; the vitta often edged on its upper side with yellowish-white; a very slender, black, dorsal line, often partially obsolete. Scutel glabrous, dark brown. Poisers black, their pedicels white. *Abdomen* clothed with longish gray hairs, black or dark brown, with two rows of whitish spots on each side; in the males obscure white, the posterior margins of the segments black. *Wings* sub-hyaline, with two blackish spots on the anterior margin, separated by a

[* Is *Anophales quadrimaculatus* Say: in Long's Exp., Append., ii, 1824; Compl. Writ., i, 1859, p. 241.]

conspicuous glossy yellowish-white spot; inner spot with a strong notch on its posterior side which is formed by a yellowish-white dot, and a similar dot is placed on the inner side of this spot; outer spot with an oblique yellowish-white band on its outer side, beyond which at the tip of the wing, is a slight blackish transverse spot. Under a magnifier, these spots are found to be produced by the colors of the scales upon the nerves of the wings, which scales are regularly and beautifully dyed with black and yellowish-white, as follows: the posterior or anal nerve has black scales the last half of its entire length, and also at its base; the next or interno-medial nerve, which forks in its middle, is clothed throughout with black scales, including both its branches; the next or externo-medial has black scales on the basal fourth of its length, two broad annuli of black scales on its middle, another annulus at its fork, and a fifth series at the tips of each of its branches; the next is clothed with black scales through its entire length; the next is black where it first becomes plainly visible in the middle of the wing, again for a short distance after the origin of the preceding nerve, again for a considerable space of its fork, and again at the apex of its posterior branch only; the costal and the marginal nerves have black scales from their bases; these become much more dense at the black spots of the anterior margin, and are replaced by yellowish scales only between these spots and beyond the entire one. *Legs* black; femurs pale toward their bases; tips of femurs and of tibiæ whitish. Coxæ pale.

The Winter Musketoe is met with in the last days of autumn and again for a short time in the first days of spring, and specimens are occasionally found in any of the winter months. It is a somewhat rare insect, which no one can fail to distinguish clearly by the marks on its wings as above described.

6. Chironomus nivoriundus. *The Snow-born Midge.*

Black; poisers obscure-brown; wings pellucid-cinereous, their anterior nervures blackish.

Length about 0.15 to the tip of the abdomen in the males; females a third shorter.

This species is black throughout, and clothed with fine black hairs. The *thorax* has three slightly elevated longitudinal ridges immediately forward of the scutel. The *wings*, when the insect is at rest, are held against the sides of the abdomen, often vertically in the males, but more commonly in the females with their inner margins in contact, thus forming a steep roof covering the back. They are diaphanous, of a cinereous tinge, and feebly iridescent. Their inner margins toward their bases are slightly arcuated. The submarginal or postcostal nervures, those which bound the closed basillary cell, and which proceed from this cell to the margin, are particularly obvious, being of a blackish color, excepting the nerve which proceeds from the inner angle of this cell to the apex of the wing, which, with the nervures inside of it, scarcely differ in color

from the surface which they ramify. The *poisers* are obscure-brownish, truncated at their apices, the capitulum being in the form of a reversed triangle. The *abdomen* in the females is shorter than the wings, somewhat compressed, approaching to an ovate form when viewed laterally, with the venter often of a dull brownish tinge; in the males it projects beyond the tips of the wings, is slender, cylindrical or very slightly tapered toward the tip, with some of the terminal segments separated by a strong contraction.

This is a very common species, appearing upon the snow in the winter season, and upon fences, windows, etc., in the fore part of spring, the males and the females being about equally numerous. The beautiful plumose antennæ of the former distinguish them at a glance from all other insects abroad at this season. At times they may be met with in immense swarms. April 27th, 1846, in a forest, for the distance of a fourth of a mile, they occurred in such countless myriads as to prove no small annoyance to the passer, getting into his mouth, nostrils and ears at every step, and literally covering his clothing. These had probably hatched from the marshy border of an adjoining lake, on this and the preceding days, the weather having been remarkably warm and dry. The wings appear to be more hyaline and iridescent in those individuals that come forth earliest, but I am unable to detect any marks by which they may be characterized as specifically distinct from those which appear at a later day.

7. TRICHOCERA BRUMALIS. *The Mid-winter Trichocera.*

Brownish-black; wings and legs pallid at their bases; poisers blackish, their pedicels whitish.

Length of the male 0.18, of the female 0.25, the wings expanding twice these measurements.

Thorax with an obscure grayish reflection. *Abdomen* in the males cylindrical, slightly narrower toward the tip, in the females elongated-oval and pointed at the tip; each segment with a strongly impressed transverse line in its middle, and the posterior margin elevated into a slight ridge. *Ovipositor* fulvous, sometimes tinged with blackish. *Wings* hyaline, faintly tinged with dusky; inner margins ciliated with quite short hairs; nervures blackish. *Legs* very long, slender, and fragile, blackish; femurs brown, gradually paler toward their bases.

Common in forests in the winter season, coming out in warm days, flying in the sunshine, and alighting upon the snow, its wings reposing horizontally upon its back when at rest. Even when the temperature is below the freezing point, and the cold so severe as to confine every other insect within its coverts, this may be met with abroad upon the wing. It is a plain, unadorned species, closely allied in its character and habits to the European *T. hyemalis*, but in a number of impaled specimens before me, I can detect no stripes or bands upon the thorax; whilst the very obvious character of the legs and wings being pallid at their bases, I do not find mentioned as pertaining to that species.

8. PODURA NIVICOLA. "*The Snow-flea.*"

Black or blue-black ; legs and tail dull brown.

Length 0.08.

Body black, covered with a glaucous blue-black powder but slightly adherent, and sparingly clothed with minute hairs ; form cylindrical, somewhat broader toward the tail. *Antennæ* short and thick, longer than the head. *Legs* above blackish, beneath dull brown and much paler than the body. *Tail* of the same color with the venter, shortish, glabrous on its inner or anterior surface, with minute hairs on the opposite side ; its fork brownish.

Though found in the same situations as the European *P. nivalis*, ours is a much darker colored species. Say's *P. bicolor* is a larger insect than the one under consideration, and differs also in size and in the color of the tail or spring. From the habits of the present species, we should infer that it might be abundant in all the snow-clad regions of the northern parts of this continent ; it may, therefore, prove to be identical with the *P. humicola* of Otho Fabricius (Fauna Groenlandica), of which we are unable to refer to any but short and unsatisfactory descriptions, which do not coincide well with our insect.

This is an abundant species in our forests in the winter and fore part of spring. At any time in the winter, whenever a few days of mild weather occur, the surface of the snow, often, over whole acres of woodland, may be found sprinkled more or less thickly with these minute fleas, looking at first sight, as though gunpowder had been there scattered. Hollows and holes in the snow, out of which the insects are unable to throw themselves readily, are often black with the multitudes which here become imprisoned. The fine meal-like powder with which their bodies are coated, enables them to float buoyantly upon the surface of water, without becoming wet. When the snow is melting so as to produce small rivulets coursing along the tracks of the lumberman's sleigh, these snow-fleas are often observed, floating passively in its current, in such numbers as to form continuous strings ; whilst the eddies and still pools gather them in such myriads as to wholly hide the element beneath them.

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